












# Bees of subfamily Nomiinae (Hymenoptera, Halictidae) from Southern Punjab, Pakistan

Huanhuan Chen<sup>1\*</sup>, Waseem Akram<sup>2,3\*</sup>, Muhammad Naeem<sup>1</sup>, Nawaz Haider Bashir<sup>1</sup>,  
Sabir Hussain<sup>2</sup>, Maryam Riasat<sup>4</sup>, Asif Sajjad<sup>3</sup>, Ruilin Tian<sup>5</sup>, Ammad Ahmad<sup>6</sup>,  
Muhammad Khalid Rafique<sup>2</sup>, Zamin Hussain Dahri<sup>2</sup>

<sup>1</sup> College of Biological Resources and Food Engineering, Qujing Normal University, Qujing 655011, Yunnan, China

<sup>2</sup> Honeybee Research Institute (HBRI), National Agricultural Research Centre (NARC), Islamabad, Pakistan

<sup>3</sup> Department of Entomology, The Islamia University of Bahawalpur, Bahawalpur, 63100, Pakistan

<sup>4</sup> Department of Zoology, Faculty of Engineering and Applied Sciences, Riphah International University, Faisalabad Campus, Faisalabad, 38000, Pakistan

<sup>5</sup> Key Laboratory of Biodiversity Conservation and Sustainable Utilization for College and University of Inner Mongolia Autonomous Region, College of Life Science and Technology, Inner Mongolia Normal University, Hohhot 010022, China

<sup>6</sup> Beekeeping and Hill Fruit Pest Research Station, Murree, Pakistan

Corresponding authors: Nawaz Haider Bashir ([haiderynau170@yahoo.com](mailto:haiderynau170@yahoo.com)); Ruilin Tian ([tianrl@imnu.edu.cn](mailto:tianrl@imnu.edu.cn))



Academic editor: Thorleif Dörfel

Received: 22 October 2024

Accepted: 12 March 2025

Published: 19 May 2025

ZooBank: <https://zoobank.org/B6EFAC9D-D854-43C8-A461-0E510070A91F>

**Citation:** Chen H, Akram W, Naeem M, Bashir NH, Hussain S, Riasat M, Sajjad A, Tian R, Ahmad A, Rafique MK, Dahri ZH (2025) Bees of subfamily Nomiinae (Hymenoptera, Halictidae) from Southern Punjab, Pakistan. ZooKeys 1238: 269–296. <https://doi.org/10.3897/zookeys.1238.139993>

Copyright: © Huanhuan Chen et al. This is an open access article distributed under terms of the Creative Commons Attribution License ([Attribution 4.0 International – CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)).

## Abstract

To date, 26 species of the subfamily Nomiinae are known to occur in Pakistan. Among these, most of the species have been reported from the northern parts of Punjab, particularly the Pothwar region. In this study, sweat bees from the subfamily Nomiinae were collected from six districts of southern Punjab, Pakistan, to identify their taxonomic diversity. A total of nine species from four genera i.e., *Austronomia* Michener, 1965, *Lipotriches* Gerstaecker, 1858, *Nomia* Letreille, 1804, and *Pseudapis* Kirby, 1900 were identified. These species were *Austronomia pilipes* (Smith, 1875), *Lipotriches* (*Armatriches*) *fervida* (Smith, 1875), *L. (Lipotriches) fulvinerva* (Cameron, 1907), *Nomia (Leuconomia) interstitialis* Cameron, 1898, *N. (Nomia) curvipes* (Fabricius, 1793), *N. (Hoplonomia) westwoodi* (Gribodo, 1894), *Pseudapis (Pseudapis) nilotica* (Smith, 1875), *P. (Pseudapis) oxybeloides* (Smith, 1875), and *P. (Nomiapis) bispinosa* (Brulle, 1832). All the bee species except *P. oxybeloides* are reported for the first time from southern Punjab, Pakistan. A key to the genera of the subfamily Nomiinae, species, diagnoses, floral hosts, and distributions are provided. Moreover, habitus photographs and male genitalia illustrations are provided for each species except *L. fervida* and *L. fulvinerva*, as no male specimens were collected during the entire study period. This study will be helpful in the establishment of conservation strategies for native bees.

**Key words:** *Austronomia*, checklist, keys, *Lipotriches*, *Nomia*, *Pseudapis*, taxonomy

## Introduction

Insects, particularly bees, provide the most important ecosystem service, leading to an increase in quality and quantity (Potts et al. 2010) of approximately 35% of crop production globally (Klein et al. 2007). The bees originated approximately 120 million years ago and are considered an ancient group of insects (Roubik 1992). Bees have been traditionally involved in human civilization,

\* These authors contributed equally to this work.



especially in agriculture and rural economies (Combey 2008). There are more than 20,000 bee species found throughout the world (Michener 2007), and among these solitary bees are more abundant than neither produce honey nor other by-products nor live in hives but provide pollination services as pollinating agents of wild and cultivated plants (Luck et al. 2009; Gallai et al. 2009). A few features make them more efficient pollinators than others, i.e., the scopa or special hairs on their body for carrying pollen grains (Karunaratne and Edirisinghe 2006; Sajjad et al. 2019a, Akram et al. 2022; Akram and Sajjad 2022) and the ability of sonication or buzz pollination (Abrol 2015; Russell et al. 2016). Most of the pollination studies have found that these solitary bees are equal to or higher in efficiency than the domesticated honey bee (Kremen et al. 2002; Winfree et al. 2007; Mayes 2011; Breeze et al. 2011; Ollerton et al. 2011; Hogendoorn and Keller 2012; Rader et al. 2012; Garibaldi et al. 2014). Vaughan et al. (2007) assessed the value of ecosystem services, especially pollination provided by the native bees (non-*Apis*) in North America alone, to be ~ 3 billion US dollars.

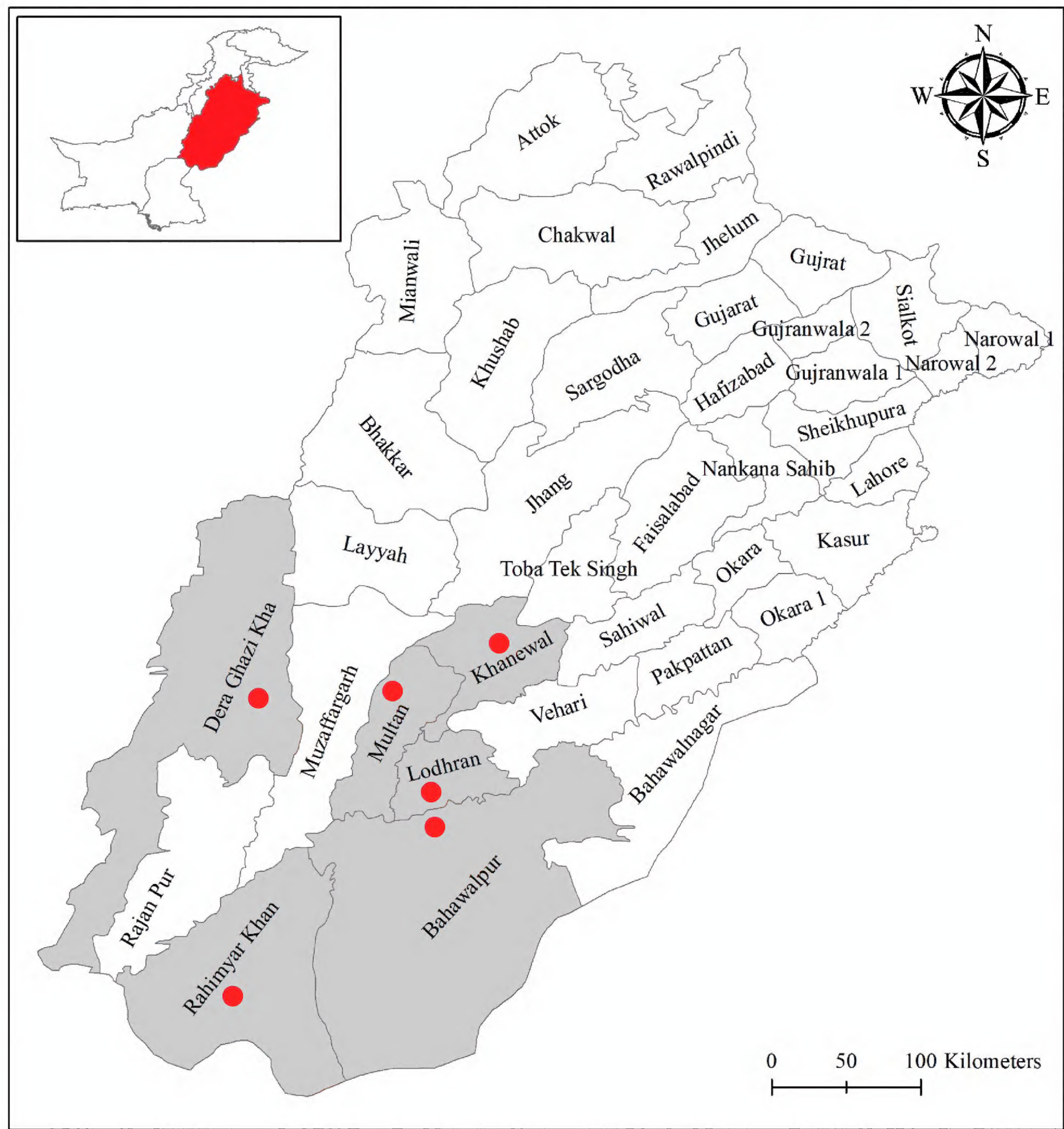
Bees of the superfamily Apoidea are classified into seven families, i.e., Apidae, Andrenidae, Colletidae, Halictidae, Megachilidae, Melittidae, and Stenotritidae (Michener 2000, 2007). Among these, Apidae is considered the largest bee family, containing ~ 6184 described species, followed by Halictidae, which includes more than 4494 species throughout the world (Ascher and Pickering 2024). The subfamily Nomiinae consists of 17 genera with 626 reported species throughout the world (Ascher and Pickering 2024). From Pakistan, ~ 335 bee species have been reported so far and among them, 26 species are from the subfamily Nomiinae (Ascher and Rasmussen 2010; Ascher and Pickering 2024).

Almost all of the literature regarding the taxonomic identity of Nomiinae bees is documented only for the genus *Nomia* from the Potohar region of Pakistan (Bodlah et al. 2016; Aslam et al. 2020; Bodlah et al. 2020). No literature is documented about the bees of the subfamily Nomiinae from southern Punjab, Pakistan. Therefore, this study aimed to assess the taxonomic identity of Nomiinae bee genera i.e., *Austronomia*, *Lipotriches*, *Nomia*, and *Pseudapis* from southern Punjab, Pakistan.

## Materials and methods

The study was carried out in six districts of southern Punjab, i.e., Bahawalpur (29°24'33"N, 71°39'50"E), Lodhran (29°31'58"N, 71°37'51"E), Rahimyar Khan (28°25'1"N, 70°18'15"E), Khanewal (30°18'53"N, 72°2'2"E), Multan (30°11'24"N, 71°27'28"E), and Dera Ghazi Khan (30°2'56"N, 70°37'1"E) (Fig. 1). Geographically, south Punjab is situated in the center of the Pakistan consists of 11 districts divided in three divisions, Bahawalpur, Dera Ghazi Khan, and Multan with a total area of 102,301 km<sup>2</sup> (Primary & Secondary Healthcare Department 2023). The area experiences a sub-tropical arid climate, characterized by a short cold winter and a long hot summer. There are four different seasons in this region, autumn from September to November, winter from December to February, spring from March to May, and summer from June to August. The spring season witnesses ~ 60% of the plant species blossoms (Sajjad and Saeed 2010, 2012). The region has a variety of bee-supporting landscapes, including agricultural fields, deserts, hill torrents, and artificial forests. The natural vegetation includes desertic herbs, shrubs, and trees.





**Figure 1.** Map of Punjab Province reflecting the major districts of southern Punjab. The districts highlighted in grey are the collection sites (collected randomly for three consecutive days from various land use types, i.e., desert, forest, public parks, alongside roads, and agricultural fields). Red circle points indicate the collection sites.

Nomiinae bees were collected from the first week of October 2019 to the fourth week of September 2021. Sampling was done fortnightly on three consecutive days in the desert, forest, and public parks, alongside roads, and in agricultural fields. Clear and sunny days were selected and rainy and cloudy days were avoided for the sampling. During each sampling day, a random walk was carried out from 0800 hr to 1200 hr, focusing on all the available plant species in flower. A professional entomological aerial net was used to collect specimens as it is an easy and efficient method (Dafni 1992). The bees were immediately killed using ethyl acetate fumes and placed in separate plastic



pouches with appropriate labels indicating the location, date, host plant, and collector name, and then shifted to the laboratory for further processing.

In the laboratory, the specimens were properly pinned and labeled with ~3 entomological pins. The first label of each specimen contained information regarding location, date, host plant, and collector name, while the second label contained information regarding taxonomic identity. Pinned specimens were placed in the bee collection drawers.

After pinning, the male specimens became hard, therefore the male specimens of species for genitalia extraction were placed in the relaxing chamber for 24 hours, and then the abdomen of the specimen was removed and placed in petri dishes with proper tagging. A solution of 10% KOH was prepared and poured into a petri dish. The abdomen was kept for 24 hours in the solution to soften the body parts. Genitalia were removed under the stereomicroscope (IRMECO, IM-SZ-500, Schwarzenbek, Germany). The skeletal parts were separated using a pair of sharp needles and fine forceps. The dissected genitalia were preserved in small glass vials containing 70% ethanol.

Bees were identified up to the family, subfamily, tribe, genus, and subgenus level by using the keys provided by Michener (2007). Species were identified using the most relevant published literature (Bingham 1897; Pauly 2008, 2009; Bodlah et al. 2016, 2020; Majumder et al. 2020). Species-level keys for each genus were prepared. Specimens were deposited to the Entomology Laboratory, Faculty of Agriculture and Environment (FA&E), The Islamia University of Bahawalpur (**IUB**). Plants visited by the bees were identified by the local experts (see Acknowledgments).

Each specimen was photographed from the dorsal and lateral sides using a digital camera (Canon 600D) mounted with a 100 mm macro lens. The photographs were edited with the help of Adobe Photoshop 2021.

## Results and discussion

### Checklist of previously reported Nomiinae bees

Reference: Ascher and Pickering (2024)

#### Genus *Lipotriches* Gerstaecker, 1858

##### *Lipotriches* (*Armatriches*) *fervida* (Smith, 1875)

**Global distribution.** India and Pakistan.

**Regional distribution.** Sindh.

##### *Lipotriches* (*Lipotriches*) *fulvinerva* (Cameron, 1907)

**Global distribution.** India, Myanmar, and Pakistan.

**Regional distribution.** Punjab and Sindh.

##### *Lipotriches* (*Rhopalomelissa*) *parca* (Kohl, 1906)

**Global distribution.** Egypt, Libya, Niger, Pakistan, Saudi Arabia, Sudan, United Arab Emirates, and Yemen.



**Regional distribution.** Punjab and Sindh.

***Lipotriches (Rhopalomelissa) parcella* (Cockerell, 1911)**

**Global distribution.** Pakistan.

**Regional distribution.** Sindh.

**Genus *Austronomia* Michener, 1965**

***Austronomia pilipes* (Smith, 1875)**

**Global distribution.** Pakistan.

**Regional distribution.** Punjab.

**Genus *Macronomia* Cockerell, 1917**

***Macronomia perlucida* (Cockerell, 1911)**

**Global distribution.** Pakistan.

**Regional distribution.** Sindh.

**Genus *Nomia* Letreille, 1804**

***Nomia (Crociaspidia) buddha* Westwood, 1875**

**Global distribution.** India and Pakistan.

***Nomia (Crociaspidia) callichlora* Cockerell, 1911**

**Global distribution.** India and Pakistan.

**Regional distribution.** Punjab and Sindh.

***Nomia (Nomia) crassipes* (Fabricius, 1798)**

**Global distribution.** Bhutan, China, India, Nepal, Pakistan, Sri Lanka, Taiwan, and Thailand.

**Regional distribution.** Khyber Pakhtunkhwa.

***Nomia (Nomia) curvipes* (Fabricius, 1793)**

**Global distribution.** India and Pakistan.

**Regional distribution.** Punjab and Sindh.

***Nomia (Leuconomia) interstitialis* Cameron, 1898**

**Global distribution.** India, Pakistan, and Sri Lanka.

**Regional distribution.** Punjab.

***Nomia (Crociaspidia) vespoides* Walker, 1871**

**Global distribution.** Eritrea, Iran, Oman, Pakistan, and Sudan.

***Nomia (Hoplonomia) westwoodi* Gribodo, 1894**

**Global distribution.** Afghanistan, India, Pakistan, and Sri Lanka.

**Regional distribution.** Sindh (Karachi).

**Genus *Pseudapis* Kirby, 1900**

***Pseudapis (Nomiapis) bispinosa* (Brullé, 1832)**

**Global distribution.** Afghanistan, Algeria, Egypt, India, Iran, Iraq, Italy, China, Cyprus, Georgia, Greece, Hungary, Kazakhstan, Malta, Morocco, Pakistan, Russia, Spain, Tunisia, Turkey, Turkmenistan, and Ukraine.

**Regional distribution.** Punjab (Rawalpindi).

***Pseudapis (Nomiapis) diversipes* (Latreille, 1806)**

**Global distribution.** Armenia, Azerbaijan, China, Congo, Cyprus, France, Greece, Iran, Italy, Kazakhstan, Kyrgyzstan, Macedonia, Mongolia, Pakistan, Poland, Romania, Russia, Slovakia, Spain, Switzerland, Syria, Tajikistan, Turkey, Turkmenistan, Ukraine, and Zimbabwe.

**Regional distribution.** Baluchistan (Quetta) and Punjab (Rawalpindi).

***Pseudapis (Pseudapis) edentata* (Morawitz, 1876)**

**Global distribution.** Azerbaijan, India, Iran, Iraq, Oman, Pakistan, Saudi Arabia, Tajikistan, Turkey, Turkmenistan, and Uzbekistan.

**Regional distribution.** Baluchistan.

***Pseudapis (Pseudapis) enecta* (Cockerell, 1911)**

**Global distribution.** Pakistan.

**Regional distribution.** Sindh.

***Pseudapis (Pseudapis) flavolobata* (Cockerell, 1911)**

**Global distribution.** India, Iran, Mauritania, Pakistan, United Arab Emirates.

**Regional distribution.** Sindh (Karachi).

***Pseudapis (Nomiapis) fugax* (Morawitz, 1877)**

**Global distribution.** China, Iran, Kazakhstan, Pakistan, Russia, Turkmenistan, and Uzbekistan.

**Regional distribution.** Baluchistan.



***Pseudapis (Pseudapis) inermis* (Morawitz, 1894)**

**Global distribution.** Georgia, Iran, Israel, Pakistan, Saudi Arabia, Tajikistan, Turkmenistan, United Arab Emirates, and Yemen.

**Regional distribution.** Baluchistan (Quetta).

***Pseudapis (Pseudapis) nilotica* (Smith, 1875)**

**Global distribution.** Afghanistan, Algeria, Djibouti, Egypt, Ethiopia, Iran, Iraq, Jordan, Libya, Morocco, Niger, Pakistan, Russia, Saudi Arabia, Sudan, Turkmenistan, and United Arab Emirates.

**Regional distribution.** Baluchistan (Quetta) and Sindh (Karachi).

***Pseudapis (Pseudapis) oxybeloides* (Smith, 1875)**

**Global distribution.** Bangladesh, India, Pakistan, Sri Lanka, and Russia.

**Regional distribution.** Sindh (Gharo).

***Pseudapis (Nomiapis) squamata* (Morawitz, 1894)**

**Global distribution.** Iran, Kazakhstan, Kyrgyzstan, Pakistan, Turkmenistan, and Uzbekistan.

**Regional distribution.** Baluchistan (Quetta).

***Pseudapis (Pseudapis) stenotarsus* Baker, 2002**

**Global distribution.** Pakistan and United Arab Emirates.

**Regional distribution.** Khyber Pakhtunkhwa (Mardan).

***Pseudapis (Nomiapis) valga* (Gerstäcker, 1872)**

**Global distribution.** Armenia, Azerbaijan, Congo, Cyprus, Greece, Iran, Kazakhstan, Pakistan, Spain, Tajikistan, Turkey, and Turkmenistan.

**Regional distribution.** Baluchistan (Quetta).

**Genus *Steganomus* Ritsema, 1873**

***Steganomus bipunctatus* (Fabricius, 1804)**

**Global distribution.** India, Pakistan, and Sri Lanka.

**Regional distribution.** Khyber Pakhtunkhwa.

**Nomiinae bees from south Punjab**

A total of nine species from the genera *Austronomia*, *Lipotriches*, *Nomia*, and *Pseudapis* are newly recorded from southern Punjab, i.e., *Austronomia pilipes*, *Lipotriches fervida*, *L. fulvinerva*, *Nomia interstitialis*, *N. curvipes*, *N. westwoodi*, *Pseudapis nilotica*, *P. oxybeloides* and *P. bispinosa*, were identified and reported from southern Punjab, Pakistan.



### Key to the genera of subfamily Nomiinae

- 1 Terga with integumentary apical bands, metanotum without double projection, tergum 1 with an enameled band, females with incomplete basal plateau of hind tibiae, male with a tooth under the femur ..... **Nomia**
- Terga without integumentary apical bands (only sometimes pubescent bands), tergum 1 without an enameled band, females with complete basal plateau of the hind tibiae, male without a tooth under the femur ..... **2**
- 2 Tegulae strongly developed, the posterior border reaching the apical margin of the scutum, presence of a subocular keel, terga with pubescent apical bands ..... **Pseudapis**
- Tegulae smaller and normal in size ..... **3**
- 3 Pronotum with a keel along the entire anterior edge, female with incomplete and linear basal plateau of the posterior tibia ..... **Lipotriches**
- Pronotum without a keel on the anterior edge or if present then largely interrupted, females with the basal plateau of the hind tibia keeled or not ..... **Austronomia**

### Key to species of *Austronomia* Michener, 1965 and *Lipotriches* Gerstaecker, 1858

- 1 Body length range 10–12 mm; mesosoma dorsally covered with yellowish brown hairs (Fig. 2A); tergum 1 with snow-white pubescence (Fig. 2B) ..... **A. pilipes**
- Body length 6–7 mm; mesosoma not covered with yellowish brown hairs; tergum 1 without snow-white pubescence ..... **2**
- 2 Marginal cell in the forewings fully rounded at the apex (Fig. 2C); tibiae black and tarsi orange (Fig. 2D); metasoma coarsely punctured, not shiny, the apex of terga 1 and 2 medially with less pale layer (Fig. 2E) ..... **L. fervida**
- Marginal cell in the forewings not fully rounded at the apex (Fig. 2F); tibiae and tarsi completely orange (Fig. 2G); metasoma not coarsely punctured but shiny, the apex of terga 1 and 2 medially with shiny pale layer (Fig. 2H) ..... **L. fulvinerva**

#### *Lipotriches (Armatriches) fervida* (Smith, 1875)

Figs 2C–E, 3

*Nomia fervida* Smith, 1875.

**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀, 8 November 2020, W. Akram.

**Diagnosis. Female** (Fig. 3). Body length 7 mm. **Head:** Coarsely pitted vertex, slightly convex clypeus that is anteriorly rounded, antennae fulvous, ocelli without the bead; clypeus, gena, and area near the ocellus covered with very short, dense, pale fulvous pubescence. **Mesosoma:** Closely and finely punctured, posteriorly truncate, slightly compressed sides, the space at the base moderately wide, coarsely reticulate; femora and tibiae incrassate and swollen, ventral femora, tarsi, and tibiae black, tibial bristles of hind legs with long branches and short



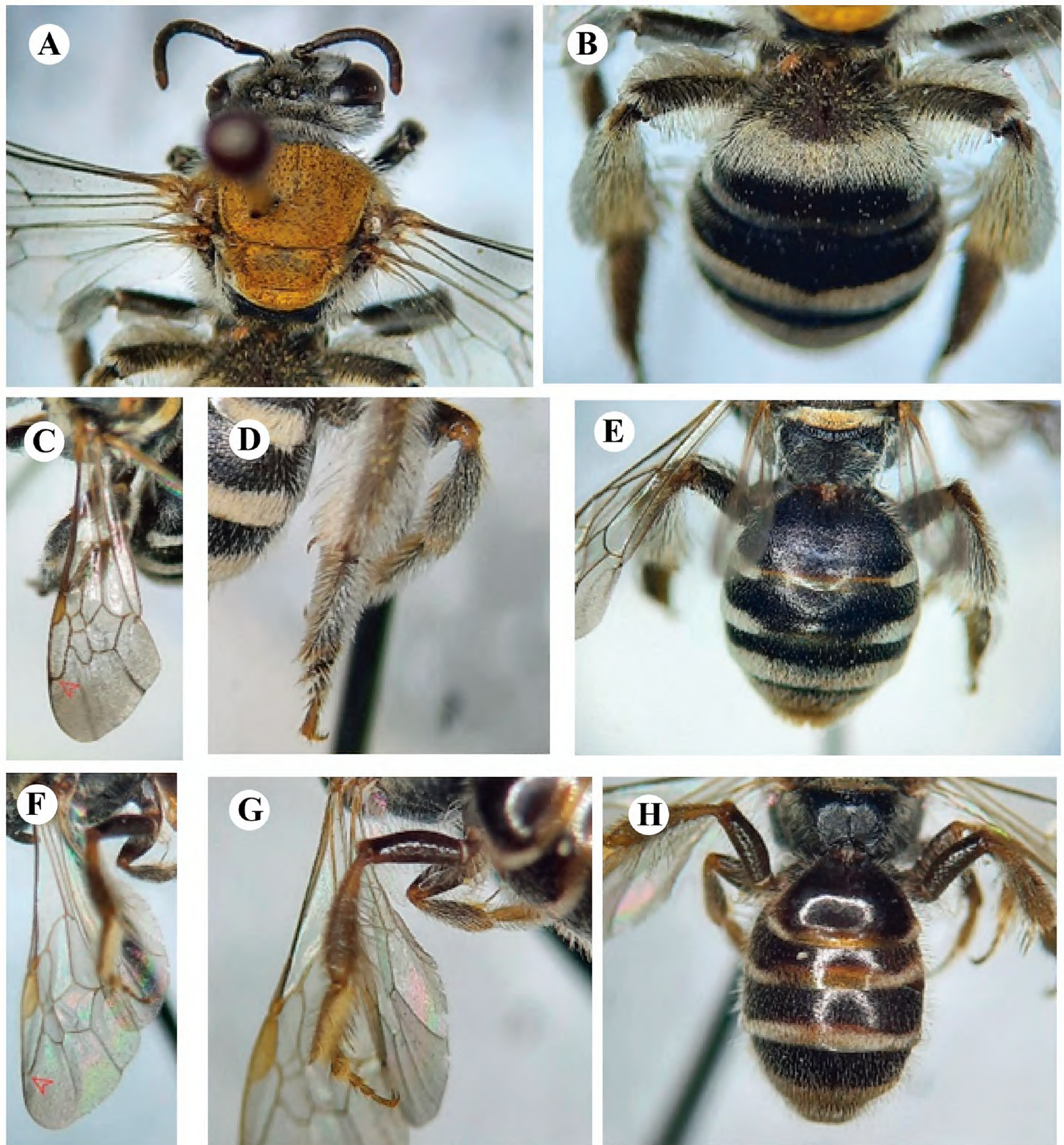


Figure 2. **A, B** *Austronomia pilipes* (Smith, 1875) **A** head and mesosoma **B** metasoma showing tergum 1 and hind legs **C–E** *Lipotriches fervida* (Smith, 1875) **C** left forewing showing the marginal cell **D** hind leg **E** metasoma in dorsal view **F–H** *L. fulvinerva* (Cameron, 1907) **F** left forewing showing the marginal cell **G** hind leg **H** metasoma in dorsal view.

rachises, wings slightly fuscous and hyaline; a fine line over the tegulae, sides of the median segment, thorax, and postscutellum; a broad transverse band on the mesonotum anteriorly covered with very short, dense pale fulvous pubescence. **Metasoma:** Closely and finely punctured, broad transverse bands on the apical margins of the terga 1–6, metasomal segments covered with very short, dense pale fulvous pubescence, fairly fine superficial punctation on tergum 1.

**Distribution.** *Lipotriches* (*Armatriches*) *fervida* is distributed in Pakistan, India, and Sri Lanka (Pauly 2009; Saini and Rathor 2012; Pauly 2014; Majumder et al. 2020; Ascher and Pickering 2024).

**Observed floral host.** *Sorghum halepense*.



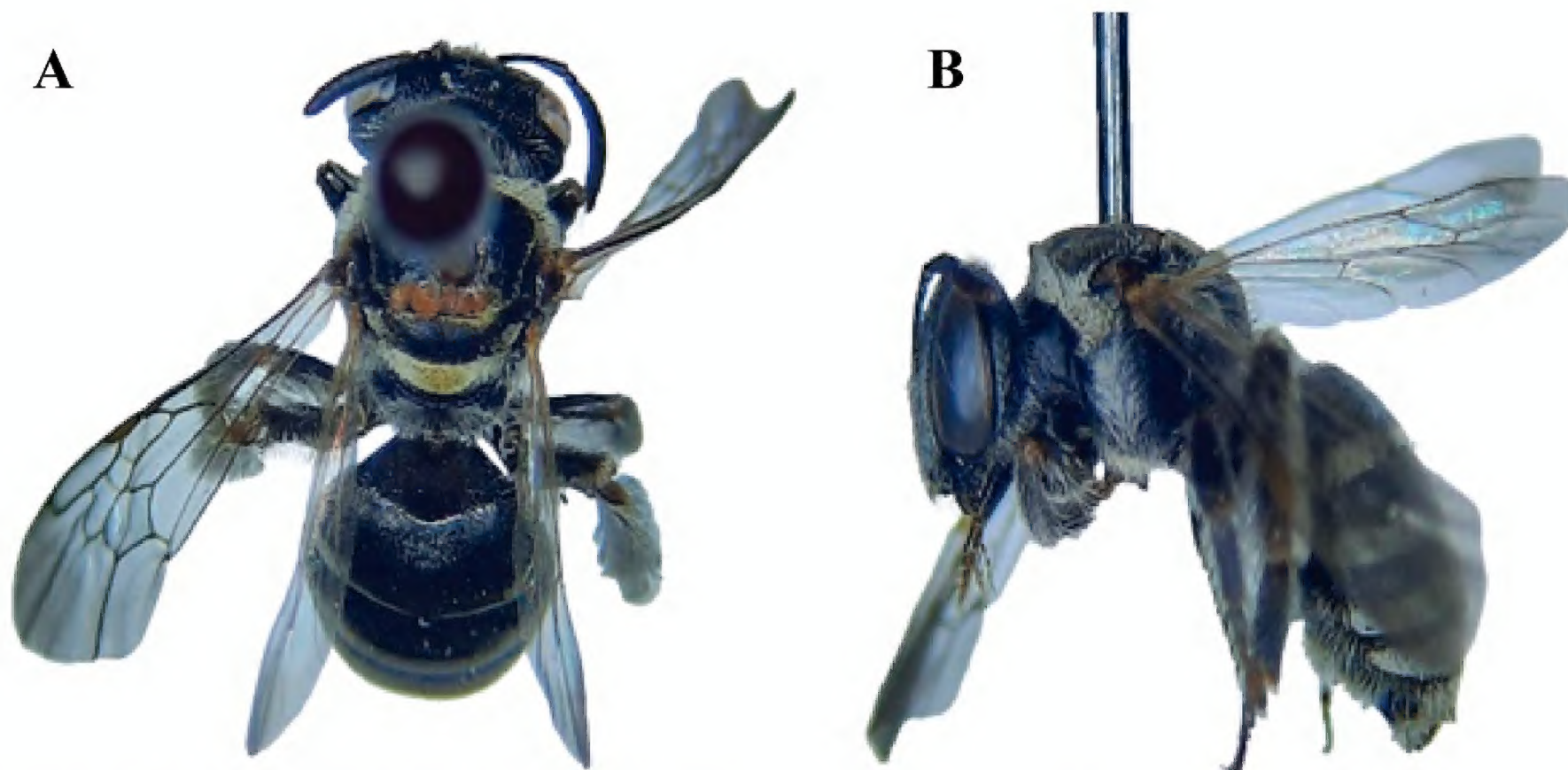


Figure 3. *Lipotriches fervida* (Smith, 1875), female **A** dorsal habitus **B** lateral habitus.

***Austronomia pilipes* (Smith, 1875)**

Figs 2A, B, 4

*Nomia pilipes* Smith, 1875.

**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀, 27 October 2020, A. Ahmad • 7♀ 5♂, 18 November 2020, W. Akram & A. Ahmad • 1♂, 23 November 2020, A. Sajjad.

**Diagnosis.** **Female** (Fig. 4A, B): Body length ranges from 10–12 mm. **Male** (Fig. 4C, D): Body length ranges from 10–11 mm. **Head:** Closely punctured and densely pubescent, antennae black, longitudinal carina absent on the clypeus, supraclypeal area and clypeus normally convex, head covered with glittering white pubescence. **Mesosoma:** Closely punctured and densely pubescent, truncate, posteriorly pubescent, bare sides; in the middle, smooth, nearly impunctate; the space at the base very coarsely punctured and concave; scutum, scutellum, and post-scutellum covered with dense beige scaly pubescence, testaceous tegulae. Wings hyaline with testaceous veins. Sides of the mesosoma covered with glittering white pubescence, abundant glittering white scopa on the hind legs. **Metasoma:** Slightly shiny, convex, and broad with a few dispersed punctures at the bases of the segments, terga 1–5 with glittering white pubescent apical bands. **Genitalia** (Fig. 4E, F): Genital gonobase small and robust, gonocoxite wider at the base and becoming narrower at the apex, gonostylus slender, and penis valves wider in the middle.

**Distribution.** *Lipotriches* (*Austronomia*) *pilipes* is only distributed in Pakistan and India (Pauly 2009; Gupta 2013; Ascher and Pickering 2024).

**Observed floral hosts.** *Salsola baryosma*, *Tamarix aphylla*, and *Datura fastuosa*.

***Lipotriches* (*Lipotriches*) *fulvinerva* (Cameron, 1907)**

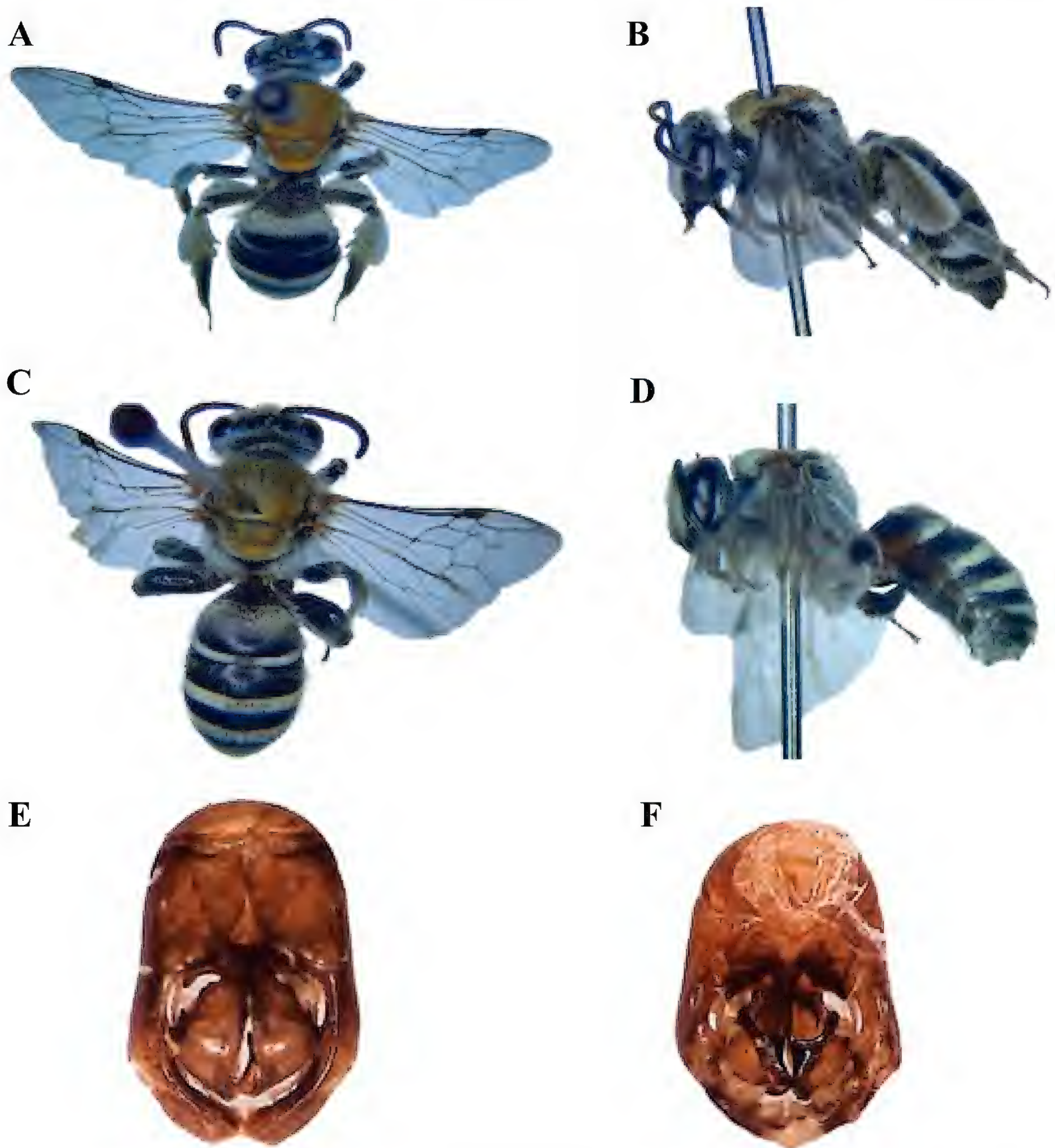
Figs 2F–H, 5

*Nomia fulvinerva* Cameron, 1907.



**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀, 17 October 2020, W. Akram.

**Diagnosis. Female** (Fig. 5): Body length ranges from 6–7 mm. **Head:** Coarsely pitted vertex, slightly convex clypeus and anteriorly rounded, antennae fulvous, scape with pale pubescence, clypeus, gena, and the area near the ocellus covered with very short fulvous pubescence, mandibles dark red. **Mesosoma:** Closely and finely punctured, posteriorly truncate, somewhat compressed sides, the space at the base moderately wide, coarsely reticulate, tibiae and tarsi completely orange, tibial bristles of hind legs with long branches and short



**Figure 4.** *Austronomia pilipes* (Smith, 1875) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.





Figure 5. *Lipotriches fulvinerva* (Cameron, 1907), female **A** dorsal habitus **B** lateral habitus.

rachises, wings slightly fuscous and hyaline, a fine line over the tegulae and a broad transverse band on the mesonotum anteriorly covered with very short, dense pale fulvous pubescence. **Metasoma:** Broad transverse bands on the apical or distal margins of the terga 1–6 abdominal segments that are covered with a very short and dense white pubescence, tergum 1 with matte punctures.

**Distribution.** *Lipotriches* (*Lipotriches*) *fulvinerva* is distributed in India, Myanmar, Pakistan, and Sri Lanka (Inoka et al. 2006; Pauly 2009; Saini and Rathor 2012; Gupta 2013; Pauly 2014; Sharma et al. 2016; Saini et al. 2018; Majumder et al. 2020; Ascher and Pickering 2024).

**Observed floral host.** *Pennisetum glaucum*.

### Key to species of *Nomia* Letreille, 1804

- 1 Basal vein in forewing slightly arched (Fig. 6A); abdominal terga with white bands (Fig. 6B); femora, tibiae, and tarsi black (Fig. 6C) ..... ***N. interstitialis***
- Basal vein in forewing not arched; abdominal terga without white bands; femora, tibiae, and tarsi not black ..... **2**
- 2 Tegulae testaceous (Fig. 6D); wings apically fuscous; abdominal terga with yellow bands, shiny and smooth (Fig. 6E); sternum black; femora, tibiae, and tarsi in males yellow (Fig. 6F) ..... ***N. curvipes***
- Tegulae partially whitish (Fig. 6G); wings apically not fuscous; abdominal terga having green bands with reddish blue effulgence, shiny and smooth (Fig. 6H); sternum testaceous; femora and tibiae in males orange-red (Fig. 6I) ..... ***N. westwoodi***

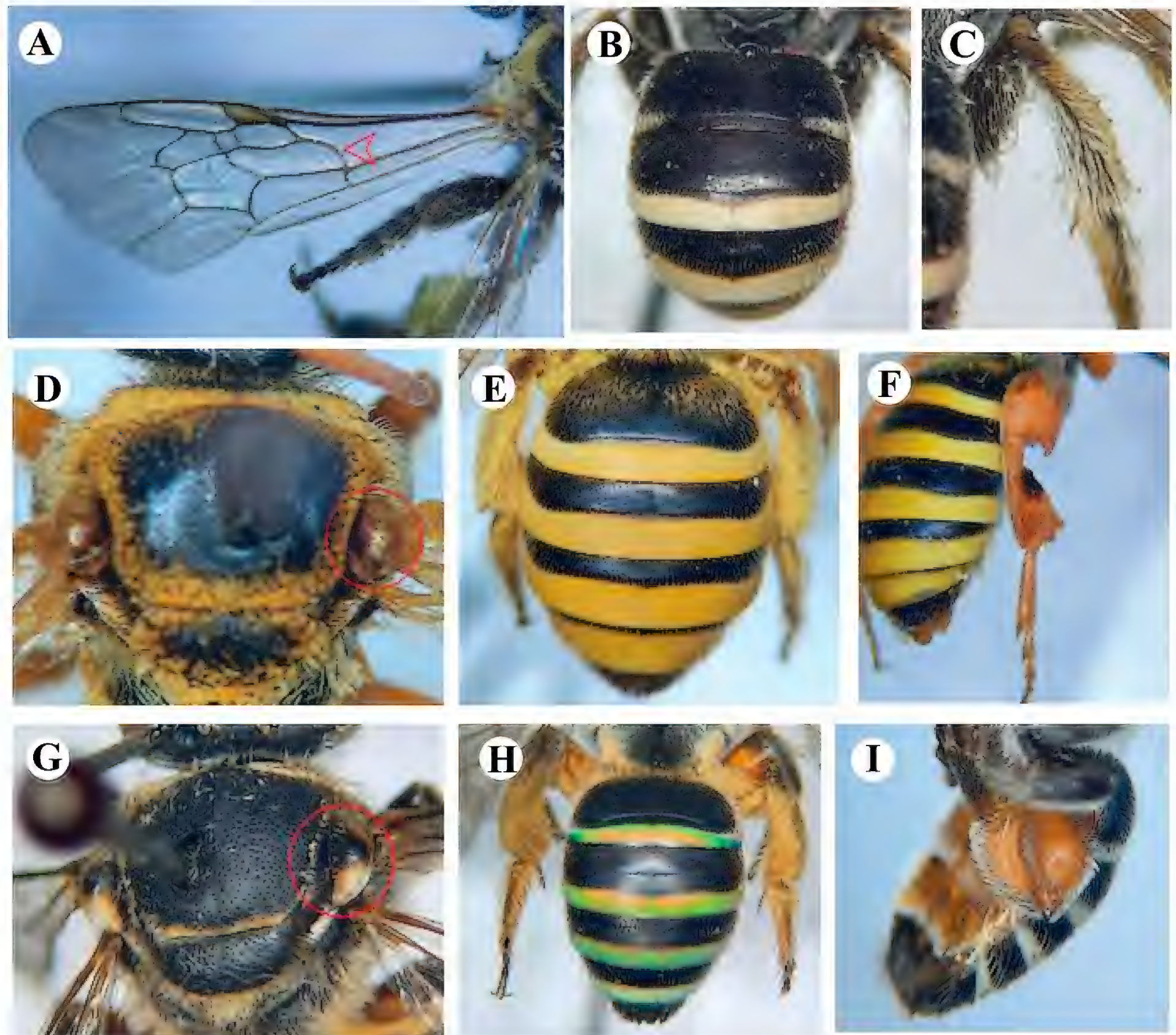
### *Nomia* (*Nomia*) *curvipes* (Fabricius, 1793)

Figs 6D–F, 7

*Andrena curvipes* Fabricius, 1793.

**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♂, 26 May 2020, A. Ahmad • 1♂, 6 June 2020, W. Akram • 1♀, 21 June 2020, W. Akram • 1♀ 2♂, 27 June 2020, W. Akram & A. Sajjad • 2♂, 28 June 2020, A. Ahmad • 2♀ 3♂, 4 July



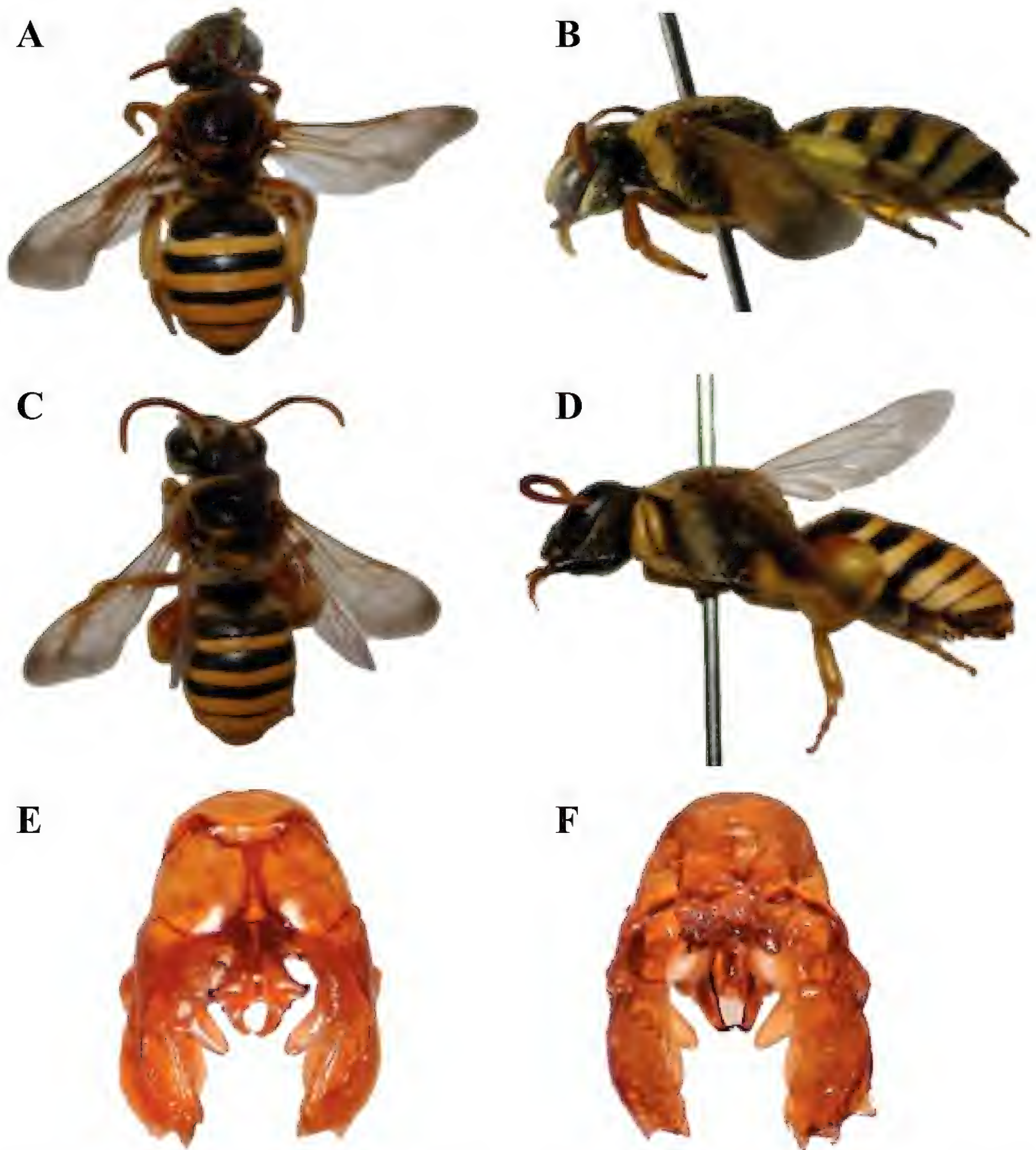


**Figure 6.** A–C *Nomia interstitialis* Cameron, 1898, female A left forewing showing basal vein B metasoma C hind leg D–F *N. curvipes* (Fabricius, 1793), D mesosoma showing tegulae of female E metasoma of female showing terga F hind leg of male G–I *N. westwoodi* (Gribodo, 1894) G mesosoma showing tegulae of female H metasoma of female showing terga I hind leg of male.

2020 • 2♀ 1♂, 11 July 2020, A. Sajjad & A. Ahmad • 3♀ 6♂, 13 July 2020, W. Akram, A. Sajjad & A. Ahmad • 4♀, 20 July 2020, W. Akram & A. Ahmad • 1♀, 21 July 2020, A. Sajjad • 1♂, 6 August viii.2020, W. Akram • 1♀ 1♂, 8 August 2020, W. Akram & A. Ahmad; 1♀, 21 September 2020, W. Akram. Lodhran • 1♀ 1♂, 27 July 2020, W. Akram & A. Ahmad • 1♀, 20 July 2020, W. Akram • 2♀, 21 July 2020, W. Akram. Multan • 1♂, 27 June 2020, M.K. Rafique • 1♀, 20 August 2020, A. Sajjad • 1♂, 27 August 2020, M.K. Rafique. Khanewal • 3♂, 15 July 2020, A. Sajjad • 1♀ 2♂, 18 September 2020, A. Sajjad & W. Akram. Rahimyar Khan • 1♂, 21 July 2020, S. Hussain • 2♀, 8 August 2020, S. Hussain & Z.H. Dahri • 1♀ 1♂, 4 October 2020, Z.H. Dahri.

**Diagnosis. Female** (Fig. 7A, B): Body length ranges from 10–12 mm. **Head:** Closely but lightly punctate, clypeus transverse anteriorly and slightly convex, antennae testaceous brown. **Mesosoma:** Dense but coarsely punctured, rounded at the sides, concavo-truncate at the apex, testaceous brown legs, hind legs





**Figure 7.** *Nomia curvipes* (Fabricius, 1793) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

covered with glittering pale pubescence, tegulae testaceous brown, median segment and mesosoma with dense fulvo-ferruginous pubescence, fulvo-hyaline wings, slightly fuscous at apical margin, veins pale. **Metasoma:** Closely but lightly punctured, the apical margins of metasomal segments 1–4 with bright yellow bands, shiny and smooth. **Male** (Fig. 7C, D): Body length ranges from 10–11 mm, hind femur very swollen, hind tibia broadened from the inner side; coxae, trochanters, and base of the femora black, femora, tibiae, and tarsi yellow. **Genitalia** (Fig. 7E, F): Genital dorsal gonocoxite teeth prominent but short and slender penis valves wider in the middle and hook-like at the apex.



**Distribution.** *Nomia* (*Nomia*) *curvipes* is distributed in India, Nepal, Pakistan, and Sri Lanka (Pauly 2008, 2009; Wijesekara 2001; Saini and Rathor 2012; Sharma et al. 2016; Chandra et al. 2019; Ascher and Pickering 2024). In Pakistan, this species has been reported from Layyah, Attock, Chakwal, Jhelum, Islamabad, and Rawalpindi (Bodlah et al. 2016; Aslam et al. 2020; Bodlah et al. 2020).

**Observed floral hosts.** *Luffa acutangula*, *Tribulus terrestris*, *Cucumis momordica*, *Citrullus lanatus*, *Convolvulus arvensis*, *Portulaca oleracea*, *Cucumis melo*, *Tamarix aphylla*, *Medicago sativa*, and *Capsicum frutescens*. Some other floral hosts i.e., *Carthamus oxycanthus* and *Phaseolus vulgaris* of *N. curvipes* have been reported (Bodlah et al. 2020).

### ***Nomia* (*Hoplonomia*) *westwoodi* (Gribodo, 1894)**

Figs 6G–I, 8

*Nomia westwoodi* Gribodo, 1894.

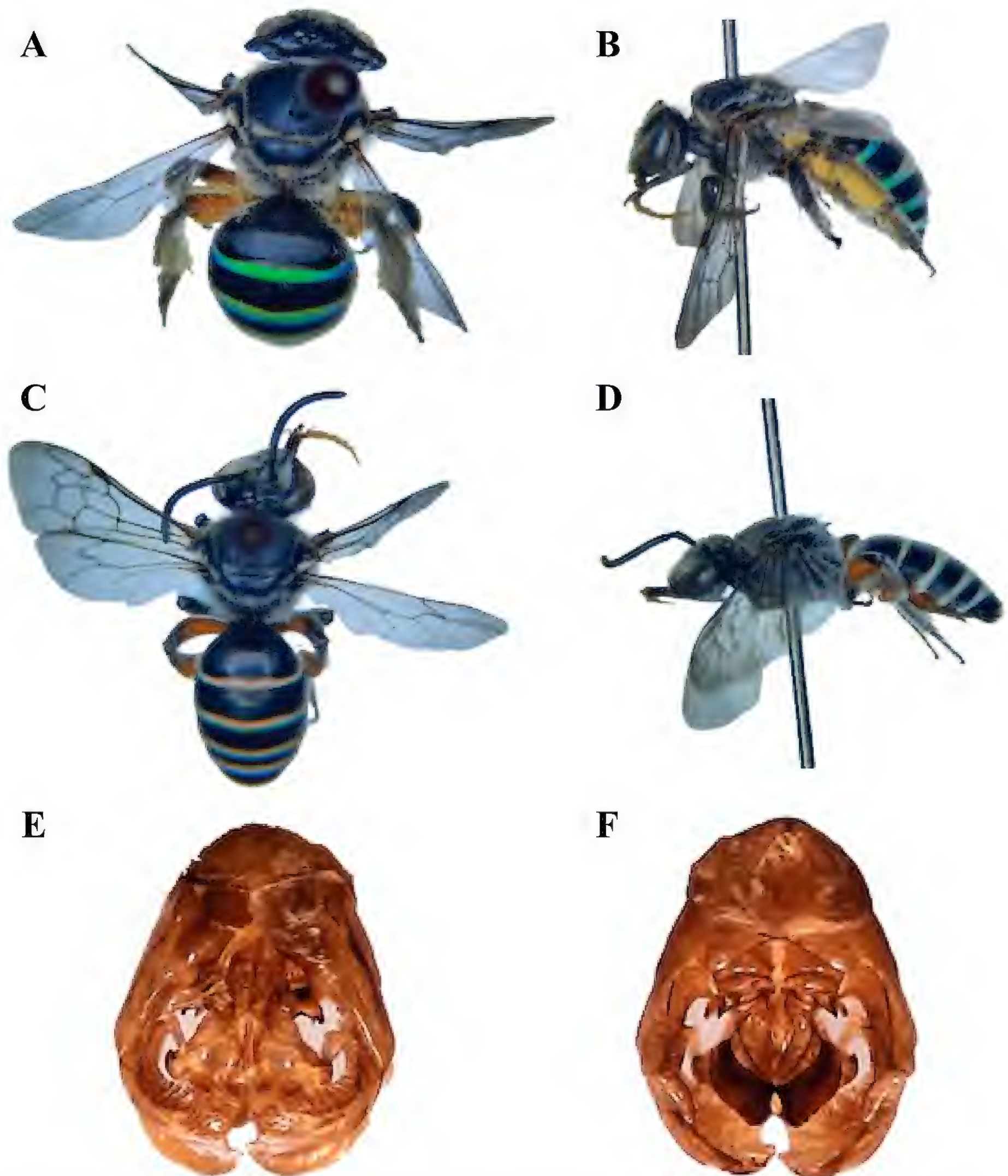
**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀ 2♂, 5 June 2020, W. Akram & A. Sajjad • 2♂, 6 July 2020, A. Sajjad • 1♂, 27 August 2020, A. Ahmad • 2♀, 8 October 2020, W. Akram • 1♂, 17 October 2020, W. Akram. Lodhran • 2♂, 6 September 2020, A. Ahmad & W. Akram. Multan • 2♂, 21 June 2020, A. Sajjad & M.K. Rafique • 1♂, 30 March 2021, A. Sajjad. Khanewal • 2♂, 29 March 2021, W. Akram & A. Ahmad. Rahimyar Khan • 3♀ 3♂, 4 October 2020, Z.H. Dahri & S. Hussain • 6♀, 5 October 2020, Z.H. Dahri & S. Hussain.

**Diagnosis. Female** (Fig. 8A, B): Length of the body ranges from 8–12 mm. **Head:** Transverse head with pale pubescence, antennae black, the apex of the mandibles with two teeth, inner much shorter than outer, clypeus not produced, 6-segmented maxillary palpi, 4-segmented labial palpi. **Mesosoma:** Black, coarsely punctured, femur and hind tibia not swollen; coxa, trochanter, and femur orange-red, tibia and tarsi black, whitish pale pubescence on hind legs, wings fuscous hyaline with rounded radial cell at the apex, three submarginal cells, 3<sup>rd</sup> longest or as long as 1<sup>st</sup>. **Metasoma:** Tergum 1–4 of metasoma with apical shiny greenish bands, sternum testaceous. **Male** (Fig. 8C, D): Body length 7–9 mm, the inner angle of the apex of the tibiae produced and rounded, posterior legs and metasoma beneath testaceous. **Genitalia** (Fig. 8E, F): Genital gonobase prominent, gonostylus apically wider, curled inward and the inner side equipped with comb-like structure, penis valves wider in the middle.

**Distribution.** *Nomia* (*Hoplonomia*) *westwoodi* is distributed in Afghanistan, India, Pakistan, and Sri Lanka (Wijesekara 2001; Inoka et al. 2006; Pauly 2009; Saini and Rathor 2012; Sharma et al. 2016; Ascher and Pickering 2024). In Pakistan, this species has been reported from Layyah, Chakwal, and Islamabad (Bodlah et al. 2016; Aslam et al. 2020; Bodlah et al. 2020).

**Observed floral hosts.** *Parkinsonia aculeata*, *Punica granatum*, *Cajanus cajan*, *Corchorus olitorius*, *Eruca sativa*, *Arachis hypogaea*, *Lagerstroemia indica* and *Luffa acutangula*. Some other floral hosts of *N. westwoodi*, i.e., *Lablab purpureus*, *Solanum melongena*, *Muntingia calabura*, *Vigna radiata*, and *Vigna* sp. have been reported (Inoka et al. 2006).





**Figure 8.** *Nomia westwoodi* (Gribodo, 1894) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

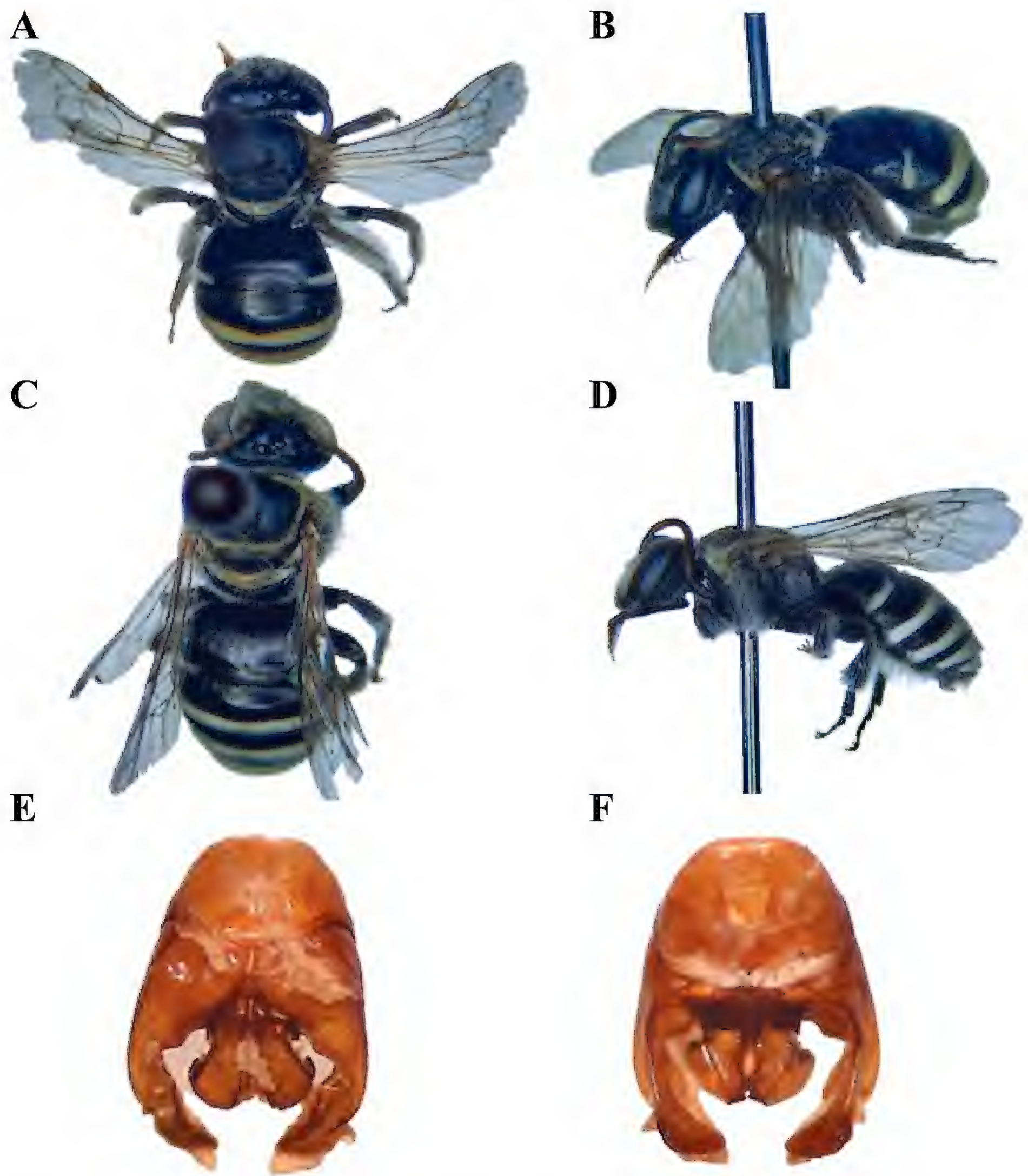
***Nomia (Leuconomia) interstitialis* Cameron, 1898**

Figs 6A–C, 9

*Nomia rothneyi* Cameron, 1904; *Leuconomia interstitialis* (Cameron, 1898).

**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀, 28 June 2020, W. Akram • 1♀, 27 July 2020, W. Akram • 1♀ 1♂, 25 August 2020, W. Akram • 1♀, 7 October





**Figure 9.** *Nomia interstitialis* Cameron, 1898, **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

2020, A. Ahmad; Lodhran • 1♀, 21 July 2020, W. Akram; Multan • 1♂, 8 August 2020, A. Sajjad; Rahimyar Khan • 2♀ 4♂, 4 October 2020, Z.H. Dahri & S. Hussain.

**Diagnosis. Female** (Fig. 9A, B): Body length 7–8 mm. **Mesosoma**: Scutum glabrous, with felted fringe only around periphery, scutellum double-humped. **Metasoma**: All terga black, enamel-like bands occupy almost the entire apical depression of the terga, tergum 1 without enamel band but with pubescent lateral fringes, tergum 1 completely matte satin with a few very shallow and



spaced punctures. **Male** (Fig. 9C, D): Body length 6–7 mm. **Mesosoma**: Scutum with fine and dense punctation, matte shagreened, glabrous except the periphery with a felted fringe; propodeum rounded, matte, the propodeal area triangular; double-humped scutellum. **Metasoma**: Sternum 3 without structures, with apical margin very slightly emarginated in its center; sternum 5 with two wide horizontal laminated structures; sternum 6 slightly wavy; sterna 2–4 with long bristles on the side parts. Tergum 1 without enamel bands but with a silky fringe on each side; hind femur and hind tibia black, not very developed. **Genitalia** (Fig. 9E, F): Genital gonobase more prominent, gonostylus apically narrower and with a bunch of hairs, penis valves wider than longer.

**Distribution.** *Nomia (Leuconomia) interstitialis* is distributed in India and Pakistan (Pauly 2009; Saini and Rathor 2012; Gupta 2013; Chandra et al. 2019; Ascher and Pickering 2024). This species is reported for the first time from southern Punjab, Pakistan.

**Observed floral hosts.** *Luffa acutangula*, *Portulaca oleracea*, *Cucumis momordica*, and *Cajanus cajan*.

### Key to species of *Pseudapis* Kirby, 1900

- 1 Antennae testaceous; head in lateral view showing carinae under the compound eye (Fig. 10A); propodeum reddish (Fig. 10B); tergum 1 completely and tergum 2 partially reddish; femora, tibiae, and tarsi orange with pale scopa (Fig. 10C) ..... ***P. nilotica***
- Antennae black; carinae under the compound eye absent; propodeum black; abdominal terga black; femora, tibiae, and tarsi black or testaceous with white scopa ..... **2**
- 2 Tegulae orange (Fig. 10D); femora, tibiae, and tarsi black in both sexes (Fig. 10E); terga with basal hair bands and without apical shiny golden layer (Fig. 10F) ..... ***P. oxybeloides***
- Tegulae posteriorly hyaline (Fig. 10G); in females, femora black, tibiae and tarsi testaceous whereas in males basitarsi yellowish and shiny (Fig. 10H); terga with basal hair bands and apical shiny golden layer (Fig. 10I) ..... ***P. bispinosa***

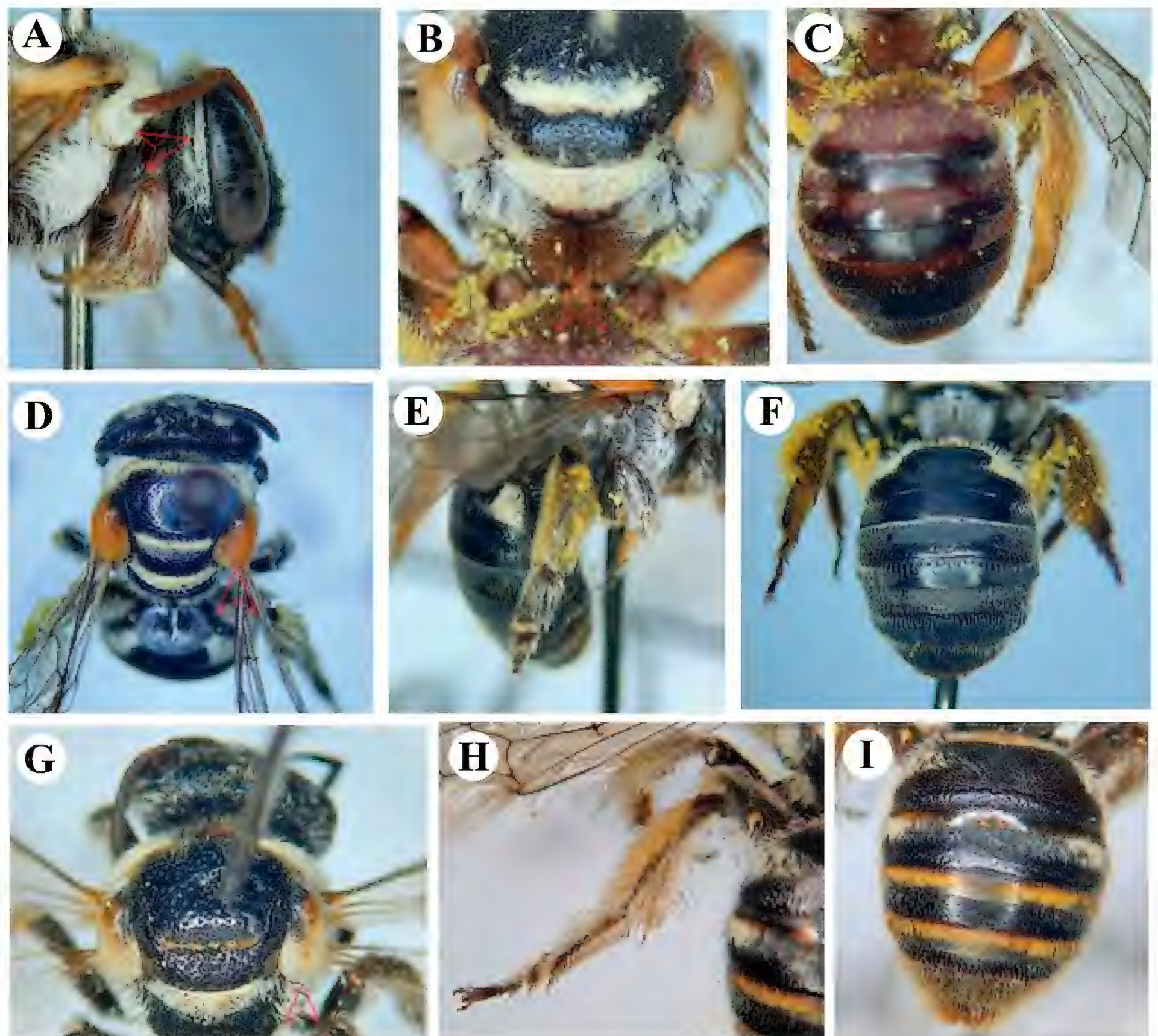
### *Pseudapis (Pseudapis) oxybeloides* (Smith, 1875)

Figs 10D–F, 11

*Nomia oxybeloides* Smith, 1875.

**Material examined.** PAKISTAN. Punjab, Bahawalpur • 1♀, 12 April 2021, W. Akram • 6♀ 2♂, 5 June 2020, A. Sajjad, W. Akram & A. Ahmad • 2♀ 1♂, 27 June 2020, A. Ahmad • 3♀ 3♂, 20 July 2020, A. Sajjad, W. Akram & A. Ahmad • 1♀, 21 July 2020, A. Ahmad • 8♀ 7♂, 8 August 2020, W. Akram, A. Sajjad & A. Ahmad; 1♀, 18 September 2020, A. Sajjad • 1♀, 24 November 2020, W. Akram; Lodhran • 2♀, 15 June 2020, A. Ahmad • 1♀ 1♂, 18 June 2020, W. Akram • 1♀, 2 August 2020, W. Akram; Multan • 3♀ 1♂, 16 June 2020, M.K. Rafique & A. Sajjad • 1♀, 18 June 2020, A. Sajjad • 2♀ 3♂, 2 August 2020, M.K. Rafique & A. Sajjad • 2♀, 3 August 2020, A. Sajjad; Khanewal • 3♀, 19 June 2020, W. Akram & A. Ahmad • 2♀ 1♂, 20



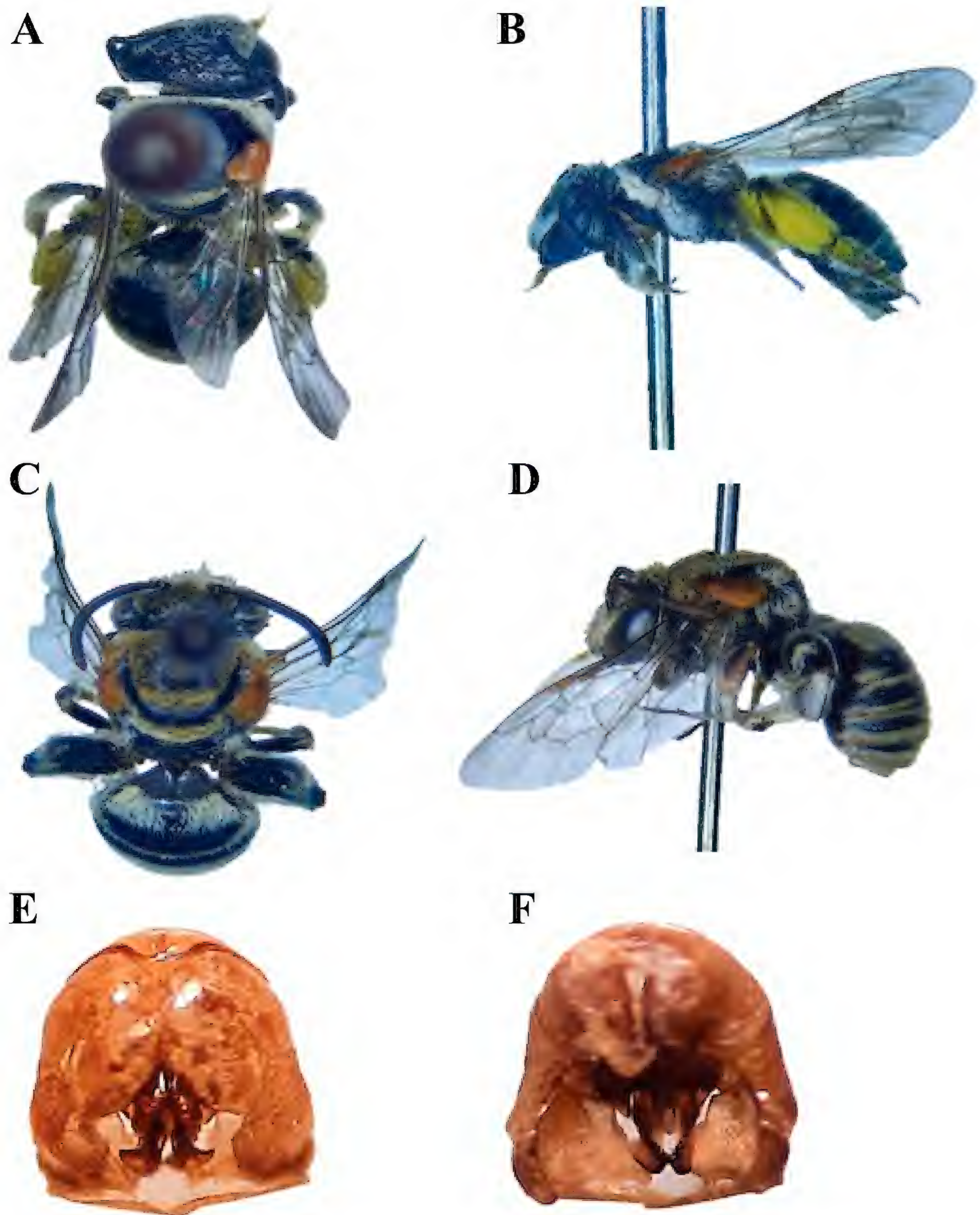


**Figure 10.** **A–C** *Pseudapis nilotica* (Smith, 1875), female **A** lateral view of head showing carinae under the compound eye **B** mesosoma showing propodeum **C** metasoma showing terga **D–F** *P. oxybeloides* (Smith, 1875), female **D** head and mesosoma showing tegulae **E** hind leg **F** metasoma showing terga **G–I** *P. bispinosa* (Brullé, 1832), female **G** mesosoma showing tegulae **H** hind leg **I** metasoma showing terga.

June 2020, W. Akram & A. Ahmad • 1♀, 4 July 2020, A. Sajjad; Rahimyar Khan • 3♀, 12 June 2020, W. Akram & A. Ahmad • 1♀, 25 August 2020, Z.H. Dahri; Dera Ghazi Khan • 2♀ 1♂, 27 August 2020, A. Sajjad, W. Akram & A. Ahmad.

**Diagnosis. Female** (Fig. 11A, B): **Head:** Densely and finely punctured, clypeus slightly flat and arched from anterior side, the head and clypeus in front with pubescence of shiny silvery white. **Mesosoma:** Coarsely and lightly punctured, tegulae very large, broader than long and testaceous, propodeum curved at the sides, sharply truncated at the posterior side and more finely punctured as compared to mesonotum, basal space very narrow, with only a row of deep rough punctures; the legs on the outside, post-scutellum, and a line on pronotum with pubescence of shiny silvery white, the mesosoma often with fulvous pubescence. **Metasoma:** Shiny, basal three metasomal segments dorsally with an unclear diagonally impressed line, margins of metasomal segments with





**Figure 11.** *Pseudapis oxybeloides* (Smith, 1875) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

pubescence of shiny silvery white. **Male** (Fig. 11C, D): Similar but smaller with a fulvous shade of pubescence, hind tibiae and femora swollen, the lower angle of each tibia from the apex produced into a long flat process with testaceous white, externally curved, the inner margin straight, hyaline wings in both sexes,



tegulae and veins testaceous. **Genitalia** (Fig. 11E, F): Genital gonocoxite robust and gonostylus lamellate.

**Distribution.** *Pseudapis* (*Pseudapis*) *oxybeloides* is distributed in Bangladesh, India, Pakistan, and Sri Lanka (Inoka et al. 2006; Ascher and Rasmussen 2010; Saini and Rathor 2012; Gupta 2013; Sharma et al. 2016; Chandra et al. 2019; Ascher and Pickering 2024). This species has already been reported from Multan, southern Punjab (Sajjad et al. 2019b).

**Observed floral hosts.** *Luffa acutangula*, *Launaea nudicaulis*, *Cucumis momordica*, *Trianthema portulacastrum*, *Capsicum frutescens*, *Convolvulus arvensis*, *Corchorus olitorius*, *Lagenaria siceraria*, *Raphanus sativus*, *Jatropha integerrima*, *Solanum virginianum*, and *Salsola baryosma*. Some other floral hosts i.e., *Cucumis sativus*, *Desmodium heterophyllum*, *Hedyotis corymbosa*, *Ipomoea mauritiana*, and *Vernonia cinerea* of *P. oxybeloides* have been reported (Inoka et al. 2006).

### ***Pseudapis* (*Nomiapis*) *bispinosa* (Brullé, 1832)**

Figs 10G–I, 12

*Nomia bispinosa* Brullé, 1832.

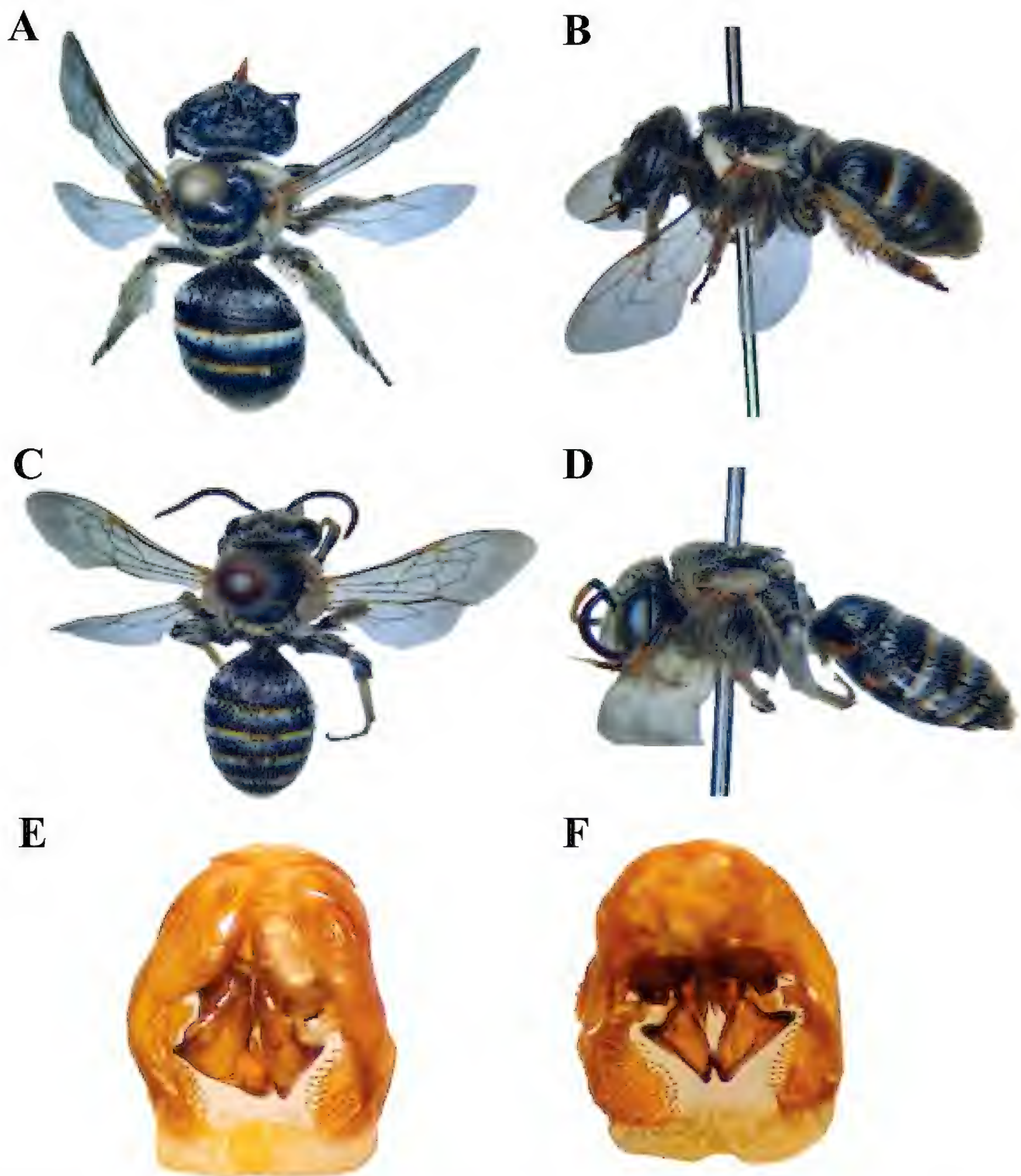
**Material examined.** PAKISTAN. Punjab, Bahawalpur • 8♀ 7♂, 9 April 2020, W. Akram, A. Sajjad & A. Ahmad • 1♂, 11 April 2020, W. Akram • 1♀ 8♂, 14 April 2020, W. Akram, A. Sajjad & A. Ahmad • 2♀ 2♂, 29 May 2020, W. Akram & A. Ahmad • 1♀ 1♂, 18 September 2020, W. Akram; Khanewal • 6♀ 13♂, 31 March 2021, A. Sajjad, W. Akram & A. Ahmad; Multan • 2♀ 1♂, 29 March 2020, A. Sajjad & M.K. Rafique • 1♀ 2♂, 30 March 2020, A. Sajjad.

**Diagnosis. Female** (Fig. 12A, B): Body length 9.5–12 mm. **Head:** Clypeus narrower ~ 2× wider than the longer, frontal line wide and prominent, vertex ~ 3× diameter of ocellus. **Mesosoma:** Tegulae posteriorly hyaline; femora black, tibiae and tarsi testaceous, mesoscutum with semi-recumbent scaly hairs along with anterior pronotum. **Metasoma:** Abdominal terga with basal hair bands and apical shiny golden layer. **Male** (Fig. 12C, D): Body length 9–11.5 mm. Mesothorax without any process on the ventral surface, scarcely developed distal process of hind tibia, basitarsi yellowish and shiny, sternum 4 with straight posterior margin, thickening in the middle and without emargination. **Genitalia** (Fig. 12E, F): Similar to *P. oxybeloides* but the inner side of the gonostylus contains comb-like structure.

**Distribution.** *Pseudapis* (*Nomiapis*) *bispinosa* is distributed in Afghanistan, Algeria, Egypt, India, Iran, Iraq, Italy, China, Cyprus, Georgia, Greece, Hungary, Kazakhstan, Malta, Morocco, Pakistan, Russia, Spain, Tunisia, Turkey, Turkmenistan, and Ukraine (Astafurova and Pesenko 2006; Ascher and Rasmussen 2010; Güler et al. 2011; Saini and Rathor 2012; Dunford et al. 2014; Safi et al. 2016; Augul 2018; Hosseini et al. 2019; Nazari et al. 2019; Lhomme et al. 2020; Ascher and Pickering 2024). This species is the first time reported from southern Punjab, Pakistan.

**Observed floral hosts.** *Tagetes erecta*, *Heliotropium crispum*, *Chrozophora tinctoria*, *Trifolium alexandrinum*, *Calotropis procera*, *Carthamus tinctorius*, *Carthamus oxyacantha*, and *Convolvulus arvensis*. Some other floral hosts i.e., *Medicago* sp. and *Mentha* sp. of *P. bispinosa* have been reported (Nazari et al. 2019).





**Figure 12.** *Pseudapis bispinosa* (Brullé, 1832) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

***Pseudapis (Pseudapis) nilotica* (Smith, 1875)**

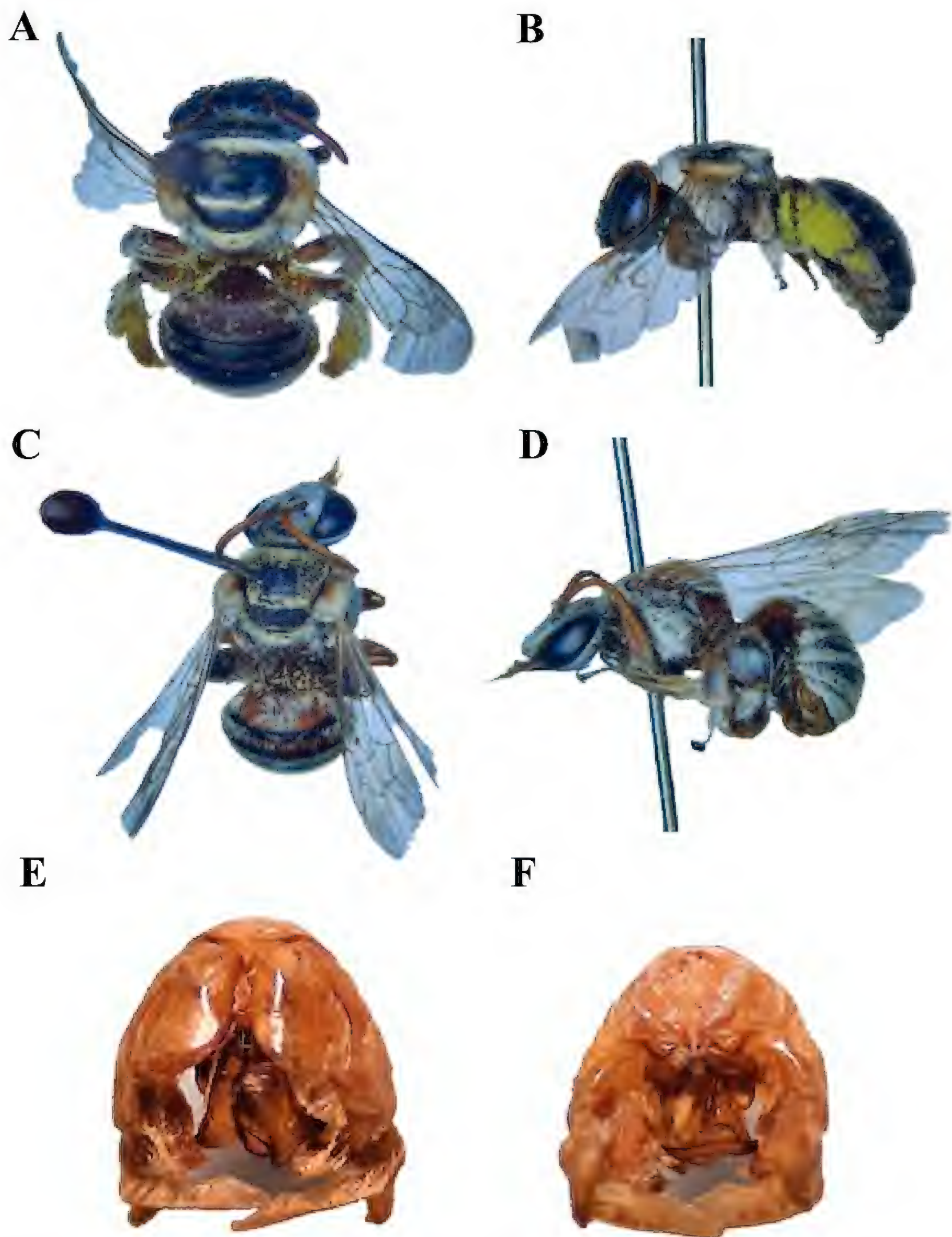
Figs 10A–C, 13

*Nomia nilotica* Smith, 1875.

**Material examined.** Bahawalpur • 5♀ 5♂, 4 July 2020, W. Akram & A. Ahmad • 1♀ 2♂, 11 July 2020, W. Akram & A. Ahmad • 2♀ 4♂, 5 September 2020, W. Akram & A. Ahmad • 1♂, 26 October 2020, W. Akram.

**Diagnosis. Female** (Fig. 13A, B): **Head:** Lateral view showing carinae under the compound eye, antennae testaceous. **Mesosoma:** Propodeum reddish, fem-





**Figure 13.** *Pseudapis nilotica* (Smith, 1875) **A** dorsal habitus, female **B** lateral habitus, female **C** dorsal habitus, male **D** lateral habitus, male **E** male genitalia, dorsal view **F** male genitalia, ventral view.

ora, tibiae and tarsi orange with pale scopa. **Metasoma:** Tergum 1 completely and tergum 2 partially reddish, S4 medioapically with a U-shaped depression bounded by two parallel callosities which arise from an extension of the disc above the marginal area, these callosities prolonged as short, blunt teeth, the emargination between them shallow; the depressed marginal area narrow, beneath the discal teeth and nearly concealed by them with two further small blunt teeth; the marginal teeth very small and nearly concealed beneath the upper



teeth. **Male** (Fig. 13C, D): Antennae testaceous, scaly hairs on the dorsal mesosoma, propodeum reddish, anterior margin of the anterior lobe of hind leg tibia angularly emarginate, metasomal tergites with white hair bands. **Genitalia** (Fig. 13E, F): Similar to *P. oxybeloides* but the gonostylus contains fringe of hairs.

**Distribution.** *Pseudapis (Pseudapis) nilotica* is distributed in Afghanistan, Algeria, Djibouti, Egypt, Ethiopia, Iran, Iraq, Jordan, Libya, Morocco, Niger, Pakistan, Russia, Saudi Arabia, Sudan, Turkmenistan, and United Arab Emirates (As-tafurova and Pesenko 2006; Ascher and Rasmussen 2010; Khodaparast and Monfared 2012; Shebl et al. 2013; Dunford et al. 2014; Augul 2018; Hosseini et al. 2019; Lhomme et al. 2020; Ascher and Pickering 2024). This species is the first time reported from the southern Punjab, Pakistan.

**Observed floral host.** *Chrozophora tinctoria* and *Citrullus colocynthis*. Some other floral hosts i.e., *Vitex agnus-castus* and *Pelargonium* sp. of *P. nilotica* have been reported (Khodaparast and Monfared 2012).

## Conclusions

Eight species of Nomiinae bees are reported for the first time from southern Punjab, Pakistan. Brief descriptions of the genitalia are also provided for each species except *Lipotriches (Armatriches) fervida* and *Lipotriches (Lipotriches) fulvinerva*, as male specimens were not found throughout the study period. Although the number of species is not large, 251 specimens were found in total. More studies are needed to further explore the numbers of genera and species of the subfamily Nomiinae from this region.

## Acknowledgments

We are thankful to Dr. Muhammad Abdullah for the identification of bee floral hosts. We are also grateful to the editor and reviewers for providing valuable comments and suggestions to improve the manuscript.

## Additional information

### Conflict of interest

The authors have declared that no competing interests exist.

### Ethical statement

No ethical statement was reported.

## Funding

This research was funded by the International Science and Technology Commissioners (Huanhuan Chen) of Yunnan Province in 2024 (Grant No. 202403AK140027), the Yunnan Provincial Department of Science and Technology “Yunnan Talent Program” plan (Grant No. 202403AM140021), the program for Innovative Research Team in Qujing Normal University, Yunnan Provincial Science and Technology Institute and Key Laboratory of Yunnan Provincial Department of Education of the Deep-Time Evolution on Biodiversity from the Origin of the Pearl River, and Agriculture Linkage Program (ALP) of Pakistan Agricultural Research Council (PARC) under project “Conservation of native bees through ecosystem approach for enhanced crop pollination (NR-191)”.



## Author contributions

WA, AA, AS, MKR, ZHD, and SH collected and prepared specimens in the field. HC, RT, and MKR provided financial and intellectual support. WA, AA, and MR prepared specimens in the laboratory. MN, NHB, SH, RT, and MKR conceived, designed, identified specimens, and prepared figures. WA, AA, and AS wrote the first draft. NHB, MN, and HC reviewed, advised, and edited the final manuscript. All authors have read and agreed to the published version of the manuscript.

## Author ORCIDs

Huanhuan Chen  <https://orcid.org/0000-0001-9477-1014>

Waseem Akram  <https://orcid.org/0000-0001-8478-2588>

Muhammad Naeem  <https://orcid.org/0000-0001-6720-5463>

Nawaz Haider Bashir  <https://orcid.org/0000-0003-0206-2435>

Sabir Hussain  <https://orcid.org/0000-0002-3532-0907>

Maryam Riasat  <https://orcid.org/0009-0003-2884-6665>

Asif Sajjad  <https://orcid.org/0000-0002-4246-1484>

Ruilin Tian  <https://orcid.org/0000-0002-6005-4014>

Ammad Ahmad  <https://orcid.org/0000-0003-1975-5609>

Muhammad Khalid Rafique  <https://orcid.org/0000-0003-3612-9765>

Zamin Hussain Dahri  <https://orcid.org/0009-0002-9634-4379>

## Data availability

All of the data that support the findings of this study are available in the main text.

## References

- Abrol DP (2015) Pollination biology. Vol. I Pests and pollinators of fruit crops. Springer International Publishing, Switzerland, 481 pp. <https://doi.org/10.1007/978-3-319-21085-8>
- Akram W, Sajjad A (2022) Pollination of *Brassica campestris* (Cruciferae) by *Andrena savignyi* (Andrenidae: Hymenoptera): Female vs. Male pollination. Sociobiology 69(1): e7300–e7300. <https://doi.org/10.13102/sociobiology.v69i1.7300>
- Akram W, Sajjad A, Ali M, Ahmad A, Ali I, Saddiq B, Yasin M, Aqueel MA (2022) Comparative effectiveness of wild bee pollination on the post-harvest characteristics of *Grewia asiatica* (Malvaceae). Journal of Asia-Pacific Entomology 25(3): 101958. <https://doi.org/10.1016/j.aspen.2022.101958>
- Ascher JS, Pickering J (2024) Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila). [https://www.discoverlife.org/mp/20q?guide=Apoidea\\_species&flags=HAS](https://www.discoverlife.org/mp/20q?guide=Apoidea_species&flags=HAS): [accessed 03 December 2024]
- Ascher JS, Rasmussen C (2010) The bee fauna and pollination in Pakistan. FAO Report, Rome, Italy, 49 pp.
- Aslam S, Rafi MA, Zia A, Munir A, Saljoki AUR (2020) Fanustic study of Non-*Apis* bees (Hymenoptera; Apoidea) from Potohar Plateau of Pakistan. International Journal of Bioscience 16(3): 221–230.
- Astafurova YA, Pesenko YA (2006) Bees of the subfamily Nomiinae (Hymenoptera: Halictidae) in Russia and adjacent countries: an annotated list. Entomological Review 86(1): 74–84. <https://doi.org/10.1134/S0013873806010040>
- Augul RS (2018) Study on diversity of bees (Hymenoptera: Apoidea) from different regions of Iraq. Bulletin of the Iraq Natural History Museum 15(1): 57–75. <https://doi.org/10.26842/binhm.7.2018.15.1.0057>



- Bingham CT (1897) Hymenoptera wasps and bees. In: Blandford WT (Eds) The Fauna of British India, Including Ceylon and Burma, VI, p. 579. Taylor and Francis, London. <https://doi.org/10.5962/bhl.title.100738>
- Bodlah I, Amjad M, Bodlah MA, Saeed M (2016) Record of Sweet Bees, Genus *Nomia* Latreille, 1804 (Halictidae: Apoidea) from Pothwar tract, Pakistan. Journal of Entomology and Zoology Studies 4(3): 178–182.
- Bodlah MA, Yasir N, Rasheed MT, Gull e Fareen A, Nawaz M, Ikram K, Waqas MM, Rasool B, Bodlah I (2020) Contribution to Non-*Apis* bee fauna of family Apidae (Hymenoptera) from Layyah, Punjab, Pakistan. Asian Journal of Agriculture and Biology 8(4): 428–435. <https://doi.org/10.35495/ajab.2020.04.227>
- Breeze TD, Bailey AP, Balcombe KG, Potts SG (2011) Pollination services in the UK: How important are honeybees? Agriculture, Ecosystems & Environment 142(3–4): 137–143. <https://doi.org/10.1016/j.agee.2011.03.020>
- Chandra K, Saini J, Gupta D (2019) Insecta: Hymenoptera: Apoidea (Bees). Fauna of Punjab, State Fauna Series 23: 1–486.
- Combey R (2008) Phylogenetic analyses of the bee Tribe Anthidiini and revision of the Afrotropical Genus *Anthidiellum* (Cockerell). PhD thesis, Department of Entomology and Wildlife of the School of Biological Sciences, University of Cape Coast.
- Dafni A (1992) Pollination ecology: a practical approach. Oxford University Press, UK, 250 pp.
- Dunford JC, Turbyville JC, Leavengood JM (2014) Checklist of medically important Hymenoptera of Afghanistan. Insecta Mundi 0339: 1–13.
- Gallai N, Salles JM, Settele J, Vaissière BE (2009) Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecological Economics 68(3): 810–821. <https://doi.org/10.1016/j.ecolecon.2008.06.014>
- Garibaldi LA, Carvalheiro LG, Leonhardt SD, Aizen MA, Blaauw BR, Isaacs R, Kuhlmann M, Kleijn D, Klein AM, Kremen C, Morandin L, Scheper J, Winfree R (2014) From research to action: Enhancing crop yield through wild pollinators. Frontiers in Ecology and the Environment 12(8): 439–447. <https://doi.org/10.1890/130330>
- Güler Y, Aytekin AM, Dikmen F (2011) Bombini and Halictidae (Hymenoptera: Apoidea) Fauna of Afyonkarahisar Province of Turkey. Journal of the Entomological Research Society 13(1): 1–22.
- Gupta RK (2013) Apoidea (Insecta: Hymenoptera) of Uttarakhand state (India): A checklist with synonymies and distribution record. Journal of Environment and Bio-sciences 27(1): 57–70.
- Hogendoorn K, Keller M (2012) Native Australian bees as potential pollinators of Lucerne (Publication No 12/048; Project No. PRJ-005657). Australian Government Rural Industries Research and Development Corporation, Canberra, 25 pp.
- Hosseini Y, Monfared A, Haghani M (2019) A survey on Halictidae (Hymenoptera: Apoidea) species available in Iranian Pollinator Insects Museum of Yasouj University. Journal of Insect Biodiversity and Systematics 5(3): 231–261. <https://doi.org/10.52547/jibs.5.3.231>
- Inoka WA, Karunaratne P, Edirisinghe JP (2006) Bee diversity in a semi-agricultural field-Sri Lanka. Biodiversity 6(4): 17–20. <https://doi.org/10.1080/14888386.2005.9712781>
- Karunaratne WIP, Edirisinghe JP (2006) Current Status and Future Directions in Bee Taxonomy in Sri Lanka. In: Bambaradeniya CNB (Eds) Fauna of Sri Lanka: Status of Taxonomy, Research and Conservation. The World Conservation Union, Colombo, Sri Lanka, 12.
- Khodaparast R, Monfared A (2012) A survey of bees (Hymenoptera: Apoidea) from Fars province, Iran. Zootaxa 3445(1): 37–58. <https://doi.org/10.11646/zootaxa.3445.1.2>
- Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, Tscharntke T (2007) Importance of pollinators in changing landscapes for world crops. Pro-



- ceedings of the Royal Society B: Biological Sciences 274(1608): 303–313. <https://doi.org/10.1098/rspb.2006.3721>
- Kremen C, Bugg RL, Nikola N, Smith SA, Thorp RW, Williams NM (2002) Native bees, native plants and crop pollination in California. *Fremontia* 30: 3–4.
- Lhomme P, Michez D, Christmann S, Scheuchl E, El Abdouni I, Hamroud L, Ihsane O, Sentil A, Smaili MC, Schwarz M, Dathe HH, Straka J, Pauly A, Schmid-Egger C, Patiny S, Terzo M, Muller A, Praz C, Risch S, Kasperek M, Kuhlmann M, Wood TJ, Bogusch P, Ascher JS, Rasmont P (2020) The wild bees (Hymenoptera: Apoidea) of Morocco. *Zootaxa* 4892(1): 1–159. <https://doi.org/10.11646/zootaxa.4892.1.1>
- Luck GW, Harrington R, Harrison PA, Kremen C, Berry PM, Bugter R, Dawson TP, de Bello F, Diaz S, Feld CK, Haslett JR, Hering D, Kontogianni A, Lavorel S, Rounsevell M, Samways MJ, Sandin L, Settele J, Sykes MT, van den Hove S, Vandewalle M, Zobel M (2009) Quantifying the contribution of organisms to the provision of ecosystem services. *BioScience* 59(3): 223–235. <https://doi.org/10.1525/bio.2009.59.3.7>
- Majumder B, Rameshkumar A, Kazmi SI (2020) Bees of grasses, *Lipotriches* Gerstaecker, Sweat bees, *Steganomus* Ritsema and *Crocisaspidia* Ashmead (Halictidae: Nomiinae), with new distribution report from Indian states. *Journal of the Entomological Research* 44(4): 589–593. <https://doi.org/10.5958/0974-4576.2020.00098.5>
- Mayes D (2011) Pollinators in Africa: Understanding is the first step to protecting. South Africa: South African National Biodiversity Institute (SANBI).
- Michener CD (2000) *The Bees of the World*, 1<sup>st</sup> ed. The Johns Hopkins University Press, Baltimore, USA, 877 pp.
- Michener CD (2007) *The Bees of the World*: 2<sup>nd</sup> ed. Johns Hopkins University Press, Baltimore and London, 953 pp.
- Nazari S, Monfared A, Nemati A, Azhari S (2019) A survey on bees (Insecta, Hymenoptera, Apoidea) and their associated mites in Chaharmahal and Bakhtiari province of Iran. *Journal of Insect Biodiversity and Systematics* 5(2): 107–120. <https://doi.org/10.52547/jibs.5.2.107>
- Ollerton J, Winfree R, Tarrant S (2011) How many flowering plants are pollinated by animals? *Oikos* 120: 321–326. <https://doi.org/10.1111/j.1600-0706.2010.18644.x>
- Pauly A (2008) Révision du genre *Nomia* sensu stricto Latreille, 1804 et désignation du lectotype de l'espèce-type *Nomia curvipes* Fabricius, 1793, non 1781 (Hymenoptera: Apoidea: Halictidae). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Entomologie* 78: 211–223.
- Pauly A (2009) Classification des Nomiinae de la Région Orientale, de Nouvelle-Guinée et des îles de l'Océan Pacifique (Hymenoptera: Apoidea: Halictidae). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique* 79: 151–229.
- Pauly A (2014) Les Abeilles des Graminées ou *Lipotriches* Gerstaecker, 1858, sensu stricto (Hymenoptera: Apoidea: Halictidae: Nomiinae) de la Région Orientale. *Belgian Journal of Entomology* 21: 1–94.
- Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O, Kunin WE (2010) Global pollinator declines: Trends, impacts and drivers. *Trends in Ecology and Evolution* 25(6): 345–353. <https://doi.org/10.1016/j.tree.2010.01.007>
- Primary & Secondary Healthcare Department [P&SHD] (2023) South Punjab Multan. <https://pshdsouthpunjab.gov.pk/about-us/> [assessed on 03 December 2024]
- Rader R, Howlett BG, Cunningham SA, Westcott DA, Edwards W (2012) Spatial and temporal variation in pollinator effectiveness: do unmanaged insects provide consistent pollination services to mass flowering crops? *Journal of Applied Ecology* 49: 126–134. <https://doi.org/10.1111/j.1365-2664.2011.02066.x>



- Roubik DW (1992) Ecology and natural history of tropical bees. Cambridge University Press, New York, USA, 514 pp.
- Russell AL, Leonard AS, Gillette HD, Papaj DR (2016) Concealed floral rewards and the role of experience in floral sonication by bees. *Animal Behaviour* 120: 83–91. <https://doi.org/10.1016/j.anbehav.2016.07.024>
- Safi Z, Nadimi A, Yazdani M (2016) The bee family Halictidae (Hymenoptera: Apoidea) collected from Gorgan county, northern Iran. *Journal of Insect Biodiversity and Systematics* 2(2): 203–217.
- Saini MS, Rathor VS (2012) A species checklist of family Halictidae (Hymenoptera: Apoidea) along with keys to its subfamilies, genera and subgenera from India. *International Journal of Environmental Sciences* 3(1): 134–166.
- Saini J, Chandra K, Kumar H, Ghosh DJ, Kazmi SI, Payra A, Deepak CK (2018) Diversity of bees (Hymenoptera: Apoidea) in and around Namdapha national park, with an updated checklist from Arunachal Pradesh, India. *Records of the Zoological Survey of India* 118(4): 413–425. <https://doi.org/10.26515/rzsi/v118/i4/2018/122129>
- Sajjad A, Saeed S (2010) Floral host plant range of Syrphid flies (Syrphidae: Diptera) under natural conditions in southern Punjab, Pakistan. *Pakistan Journal of Botany* 42: 1187–1200.
- Sajjad A, Saeed S (2012) Yearlong association of butterfly populations with flowering plants in Multan, Pakistan. *Pakistan Entomologist* 34: 105–110.
- Sajjad A, Akram W, Ali S, Farooqi MA, Mujtaba G, Ali M, Ahmad A (2019a) Pollination of *Grewia asiatica* (Malvaceae) by *Megachile cephalotes* (Hymenoptera: Megachilidae): male vs. female pollination. *Sociobiology* 66(3): 467–474. <https://doi.org/10.13102/sociobiology.v66i3.4345>
- Sajjad A, Ali M, Saeed S, Bashir MA, Ali I, Khan KA, Ghramh HA, Ansari MJ (2019b) Year-long association of insect pollinator, *Pseudapis oxybeloides* with flowering plants: Planted forest vs. agricultural landscape. *Saudi Journal of Biological Sciences* 26(7): 1799–1803. <https://doi.org/10.1016/j.sjbs.2018.02.019>
- Sharma G, Kumar PG, Gupta RK (2016) Studies on diversity of Bees (Apoidea: Hymenoptera: Insecta) from Sunderbans Biosphere Reserve including fourteen new distributional records of Bees species from West Bengal, India. *Biology Bulletin* 2(1): 43–51.
- Shebl M, Kamel S, Mahfouz H (2013) Bee fauna (Apoidea: Hymenoptera) of the Suez Canal Region, Egypt. *Journal of Apicultural Science* 57(1): 33–44. <https://doi.org/10.2478/jas-2013-0004>
- Vaughan M, Shepherd M, Kremen C, Black SH (2007) Farming for bees: Guidelines for providing native bee habitat on farms, 2<sup>nd</sup> ed. The Xerces Society for Invertebrate Conservation, Portland, 44 pp.
- Wijesekara A (2001) An annotated list of bees (Hymenoptera: Apoidea: Apiformis) of Sri Lanka. *Tijdschrift voor Entomologie* 144: 145–158. <https://doi.org/10.1163/22119434-99900063>
- Winfrey R, Williams NM, Dushoff J, Kremen C (2007) Native bees provide insurance against ongoing honey bee losses. *Ecology Letters* 10: 1105–1113. <https://doi.org/10.1111/j.1461-0248.2007.01110.x>